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ECONOMIC GEOGRAPHY

JULY

"HIGH FARMING" IN THE WEST MIDLAND COUNTIES 1840–1880
G. E. Fussell

REHABILITATION OF TRANSPORTATION IN WESTERN GERMANY
Jack A. Bradley

AGRICULTURAL LAND USE IN IOWA
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AN INDEPENDENT FARM IN CUBA
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MOUNTAIN PASSES IN THE COLORADO ROCKIES
Earl E. Lackey

SAUDI ARABIA'S PETROLEUM RESOURCES
George P. Stevens, Jr.

SEQUENCE OF PLANTATION AGRICULTURE IN CEYLON
Shannon McCune

CLARK UNIVERSITY, WORCESTER, MASSACHUSETTS, U.S.A.

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W. Elmer Ekblaw

Dr. W. Elmer Ekblaw, Editor of ECONOMIC GEOGRAPHY since its start in 1925, died on June 5 of this year. Even though he had decided to retire from the editorship at the end of this, his twenty-fifth year, his death is a great loss and the new editor will greatly miss his expert advice. ECONOMIC GEOGRAPHY was his child; he carried it almost single-handed through all those years. Not only was he able to attract, without payment, articles from most of the well-known geographers, but he also started many young geographers on the road of publications. His work as editor was of a very high quality; few have known the art of writing as well as he knew it, and his editorial advice was always to the point. ECONOMIC GEOGRAPHY will remain associated with his name; he was the man who made it a valuable asset to the geographical world. It was a job well done.

S. VAN VALKENBURG

ECONOMIC GEOGRAPHY

VOL. 25 JULY, 1949 No. 3

"HIGH FARMING" IN THE WEST MIDLAND COUNTIES 1840–1880

G. E. Fussell

THE renowned Cheshire cheese springs at once to mind when one begins to think about Cheshire farming: the greatest change that happened in Cheshire between 1840 and 1880 was diversion of part of milk produced to meet growing demand for liquid milk from the neighboring towns. Otherwise, despite incidence of the cattle plague, farming of the county was much the same at the end of the period as it was at the beginning. Nevertheless a major operation of land reclamation was carried out in the Forest of Delamere.

I. CHESHIRE

William Palin of Stapleford Hall, Chester, who had been a practical dairy farmer for 30 years in 1845 thought that there had been great improvements by the introduction of turnips as a crop and bone dust as manure during that time, and that farming of the county could be divided into sand or clay land dairies, and clay land arable at that date, there being but few sand land arable farms then. Both classes of dairy farm included long leys in their rotations, the light land being worked on a course of oats sown at six bushels on broken ley; pigs or geese run on the stubbles, which were then plowed and harrowed twice, and plowed again for wheat, followed by swedes or potatoes in drills dressed with farmyard manure or bones; then barley with seeds for four or five years. With variations, the rotation was typical.

The heavier dairy land was cropped wheat, oats with seeds left down for seven or eight years, but there were many variations here too. On heavy arable farms beans were drilled after a two-year ley; wheat; fallow or turnips or part potatoes; wheat with seeds. Potatoes were extensively grown between Runcorn and Altrincham for Manchester whence stable manure was returned on the land. Some early cabbage was also grown here after potatoes, but the crop was usually followed by wheat with clover mown and then grazed for four or five years. The long ley was intrinsic and essential part of the farming system of the county.

Some drainage had been done but much more was necessary. Marl and lime, and some crushed bones, guano and nitrate of soda were used presumably by the best farmers who had also adopted the new factory implements, Finlayson's harrow, the Uley cultivator. Ten years before the iron plow had been unknown, and there were still some wooden plows used in more remote parts of the south and west areas of the county.

Dairymen were not choice in breed of cattle used and there were many crossbreds, Yorkshire or Holderness Short-

horn, Lancashire and Staffordshire Longhorns, Devons, Ayrshire, Welsh, Irish and improved Shorthorns. Few sheep were bred, but about 65,000 were fed and they again were a mixed lot. Nevertheless the estimated number of milch cows in the county was 100,000 in 1847 and their yield averaged 200–400 pounds cheese and 15–20 pounds butter. Lavergne who made this estimate, thought half the county was grassland on which the most successful manure was bonedust from Manchester. The farms averaged about 70 acres. The Marquess of Westminster had established a factory

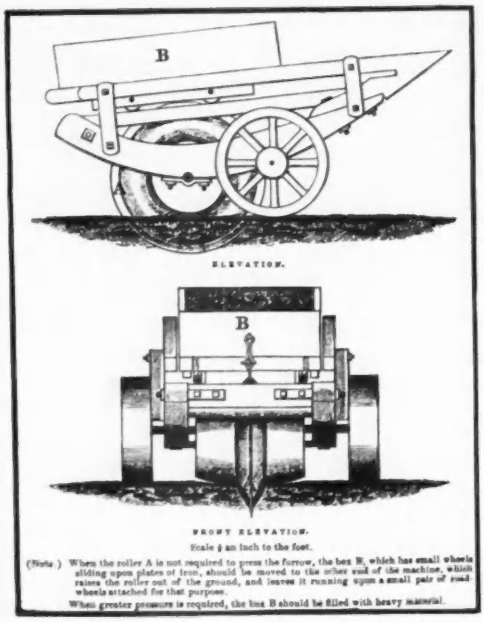
B
A
ELEVATION.
B
FRONT ELEVATION.
Scale ½ an inch to the foot.
(Note.) When the roller A is not required to press the furrow, the box B, which has small wheels sliding upon plates of iron, should be moved to the other end of the machine, which raises the roller out of the ground, and leaves it running upon a small pair of road wheels attached for that purpose.
When greater pressure is required, the box B should be filled with heavy material.

FIGURE 1.—A furrow press used in Cheshire to help condition the soil and improve tillage, an important farm implement on the farms of the middle part of the nineteenth century. (From Jour. R.A.S.E. 1844/5.)

for drain tiles and gave them to farmers who would use them. The estimate of productivity and of the system of farming was generally accepted at the time. There were, of course, superior farms, and Caird notices particularly Littledale's Farm near Seacombe which carried a selected herd of Teeswater Shorthorns, house fed; in summer on cut clover, rye grass, and vetches; in winter on brewers' grains, turnips, mangolds with linseed cake, etc., if green food were short. Here wheat yielded 15–30 bushels an acre; oats 30–36 bushels and sometimes two crops of potatoes were got in a year. A great deal of stable and cow-house manure was obtained from the towns by barge.

Part of the Forest of Delamere which lies between Chester and Northwich had been reclaimed at the end of the 18th century to the extent of 4,023 acres, besides Old and New Pale Farms of 755 acres, under lease from the Crown, and by Act of Parliament of 1856, Commissioners of Corn Lands were empowered to clear land and let it on farming leases. Honslough, an area of 248 acres, was first taken in hand. It was cleared of timber, trench plowed and marled, the marl digging being let to a contractor who could not make it pay so it had to be completed by direct labor and cost 1,797 pounds or seven pounds four shillings eleven pence per acre. Farm buildings were subsequently erected and the farm let at 30/– an acre plus an interest charge on all cost of the buildings over 500 pounds. Before the work was done the land was worth only 5/– an acre. Other areas dealt with successively in the same way were Longridge and Plover's Moss, an area of about 800 acres, completed in 1863; Organsdale, Primrose Hill, etc. Allotments about 530 acres being reclaimed in 1864. On Delamere Lodge Farm Mr. Leathers had 100 acres potatoes and 60 acres roots both heavily dressed with artificials in 1862 and a clover crop as well as barley and oats. He overwintered 1790 sheep and sold them fat in the spring and got high yields of cereals, so evidently this work was well worth-while.

Outbreaks of cattle plague naturally caused some disturbance in the dairy

Figure 2.—The sand pit near Kensington, from which a suitable quality of sand was quarried for the lightening of heavy soils and consequent increase of their productivity as well as improvement in their tilth. (By courtesy of the Trustees of The Tate Gallery.)

industry. Thomas Rigby, tenant of Darnhall Farm, Over, and founder of the Cheshire Chamber of Agriculture estimated loss by compulsory slaughter policy during outbreaks of rinderpest in 1865/6 at 35,000. Mr. Gould of Crouchley Farm near Lyman increased his tillage from 60 acres to 80 acres, out of 240 acres after the outbreak; he reduced the number of his dairy cows and increased his sheep but otherwise his farming continued to follow much the same routine as before, as was fairly general in the county. Pigs were kept on all dairy farms to consume waste products.

By the end of the period there is no marked change in the management. Arable farms which produced potatoes for the towns continued to be cropped intensively with help of town stable and dairy manure. Examples in 1877 were Kay of Warburton Park who kept a flying flock and herd and fattened mutton and beef on arable crops, and Joseph Kinsey of Royal Oak Farm near Altrincham, while outstanding dairy farms were those of Joseph Lea, Stapleford Hall near Tarvin; Robinson, Lee Green Hall, Middlewich; Chas. Hollingshead, Weaverbrook Farm, Minshell Vernon; Percival, Hall Lane Farm, Daresbury near Runcorn; Joseph Trickett, Moor Farm, near Sandway; George Millington, Horseshoe Farm, Henbury near Macclesfield; Beecroft, Upton Green; John Gregory, Waverton, while Wright of Minshull Vernon had gone over to meat production.

The main change that took place in the county during the forty years was selling liquid milk instead of making cheese and butter, although the south and east of the county remained faithful to their original industry. It was optimistically estimated that some farmers, e.g., Jackson of Noctoron had doubled his output since 1852 by use of new

manures and James Russell of Brimstage Hall and Thomas Wright of Spittal, but the county stock of cattle had decreased by 5,000 in the decade 1872–1881. There had also been a deal of laying down to grass, perhaps only to be expected in a county so traditionally devoted to grazing. On Lord Egerton's estate, Tatton Park, Knutsford, the agent, G. Carter, had laid down a large area on the home farm; Joseph Aston of Brassey Green, Tarporley had made grass of his whole farm of 173 acres "long before the rise in labor"; Thomas Finchett, Rushton, Tarporley, had only 20 acres arable of 145 held on a yearly tenancy; Charles Willis of Ridley Hall, Tarporley, had grassed and broken up following the dictates of circumstance.

Marling had been superseded by liming, the new manures including bones and salt were used as were concentrates and some new types of implements were common, a good deal of draining had been done as well as some general land reclamation in Delamere Forest, but it is quite impossible to measure the developments or indeed to judge any improvement in the class of livestock kept.

II. Derby

Derby was a county of contrasts but its physical configuration made it a breeding, rearing and dairy county rather than one of arable farming. It was what later statisticians were to call one of the grazing counties and in large part of its area, the High Peak especially, oats were preferable and certainly more usually grown than wheat. Improvements being made in the late forties were confined to large landowners and farmers with capital. Small farmers of whom there was preponderance did not possess means to follow the good examples even if they had wished to do so: they continued in "the routine of their forefathers" just as farmers elsewhere.

Some really heavy yields of oats were got by heavy manuring. Mr. Furniss of Birchills got 72 bushels per acre followed by 27 tons of swedes applying 15 tons of dung and 16 bushels of bones. He proceeded with oats or barley and seeds for two years after which he was able to take one crop of wheat. He kept 70 highly bred Shorthorns, 12 dairy cows and 20 calves and a flock of 110 Leicester ewes, the lambs being sold

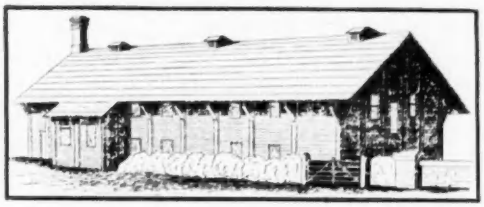

FIGURE 3.—The Longford Cheese factory, based upon American cheese-making principles, afforded the farmers of the neighborhood and Derby in general a better outlet for their surplus milk. The cheese factory was always profitable and its history was checkered. (From Jour. R.A.S.E. 1871.)

at one year old. The Hon. Cavendish of Ashford farmed on a six-course rotation and Bill Crompton of Duffield Hall had introduced Ayrshire cows. Thornton of Stanton near Bakewell got two to four hundredweight of cheese per cow, about much the same as the Cheshire yield, from a herd of 16 up to 43 cows, the number varying according to sales and purchases. Both cattle and sheep were sold to low country farmers from Derby. Much pasture, however, needed draining and drainage of the arable would have made it possible to grow turnips: potatoes were grown in rows molded up with the plow and on the best soils yielded up to 600 bushels an acre. The best pastures, e.g., the Dove valley, were very rich and would fatten the heaviest oxen. There was a good deal of horse breeding and car-

riage, saddle and farm horses were sold.

John Jephson Rowley of Mansfield supplies a more detailed account a couple of years later. On magnesium limestone in East Derby farms were well cultivated on a six- or seven- course rotation, dung, bones, guano and rape dust being liberally used. The implements were most up to date from steam engine to harrow and farmers were most anxious for success of the reaper. Many estates on the coal measures, greatly improved in the previous fifty years, had been thoroughly drained with help of "Government" money. Sheep were kept and early lambs browsed on Italian rye grass at Morton near Alfreton which had been a cold neglected morass ten years before. Near Sheffield, manures and brewers' grains were brought from the town including such diverse things as horn shavings, bone dust, of which use is believed to have originated here, refuse from the comb makers and other animal wastes. A century before, millstone grits and shales had been an uncultivated waste of heath and peat bogs, but the Dukes of Rutland and Devonshire were rapidly draining their estates, and taking in the moor to make new farms on which the four-course system was followed, good implements used and bones and guano on the root crop. Highland Stots and Galloways were bought at Brough Fair, summered on the hills and wintered in lower grounds, making good beef at three or four years old. The mountain limestone was a sheep walk and used for cattle grazing and the dairy cow, the cropping being simple, fallow or roots; oats or rape; seeds for 16–18 years, bones or guano being used on the turnips. Usually a flock of Leicester breeding ewes was kept and calves were reared, and this was the system from Buxton to Crownford. In the fortunate valley of the Dove, cheese, beef and mutton were produced and no lime was necessary as it was elsewhere.

In the county factory cheese making was first introduced by coöperation between landowners and farmers. After a report on the American system had been obtained and published in 1870 and 1871, the Midland Agricultural Society advocated its establishment in Derby, expecting to secure greater uniformity in the product, ease of labor and of course a certain price to the farmer. Five thousand pounds were subscribed to guarantee a price of six and a half pence a gallon for milk, to be paid monthly and the whey to be sold at the best possible price. A factory was provided by the Hon. E. K. W. Coke of Longford and an American, Cornelius Scharrnerhorn, imported to advise. The plant was intended to use the milk of 400 cows. Another factory was established in 1870 in Derby town to deal with that of 300 cows. Cheese was made at Longford and butter at Derby: to the latter 17 supplied 130,837 gallons of liquid milk, and to the former 27 producers supplied 170,867 gallons, but the enterprises had a chequered career.

The system of very long leys which had been part of Derbyshire farming for centuries was considered by Evans & Bowstead almost the same as laying down land to grass; and indeed John Archer of Youlgrave, Bakewell, told them that he had made a practice of laying down because he did this. He thought his farm would have paid better if it had all been in grass. Thomas Swann of Hargate Hall, Buxton, and Benjamin Buxton of Aldwark, Wirksworth, had both followed the same system. They had fairly large acreages but it is probable that a great many other Derbyshire farmers had been following the same system for long enough. It was to go through a rotation in which roots were heavily fertilized

and finish up with seeds under a corn crop, although both Archer and Buxton preferred rape as a nurse crop.

Opinion about farming of the county was divided in 1880 although it was agreed that pig-keeping had declined because of increased sale of liquid milk, some of which went to London, some to Newcastle-on-Tyne and some to the Yorkshire towns. The Midland railway is said to have carried one million gallons over its whole system in 1872 and expected five and a half million in 1881—not all Derbyshire produce of course. Cattle in the county were nearly all Shorthorns varying from beautiful herds to a few nondescript milking animals on smaller farms. Though there were few pedigree bulls, herds had been improved by use of pure-bred Shorthorn bulls during the previous 15 years. Position of the dairy farmers had improved in the same time because cheese factors had been little better than moneylenders that kept producers in thrall, and the cash payment for liquid milk had released them. Though the Longford factory had suffered from American competition from 1879, sale of their milk to the factory had benefited dairy farmers similarly. The north of the county had not felt the depression so much as the south but its folk lived and worked hard gaining a livelihood little if any better than the laborer. All over the county, however, the milk trade had saved the agricultural community, and as in other grazing counties, though the number of livestock had fallen, the farmers were not in such desperate case as in corn and sheep counties. The cereal area was declining but good barley found market in Burton breweries which returned "grains" for feeding. Peas and beans were also going out of fashion and potatoes were being more extensively grown. Cake feeding on pastures was considered a cheap and easy improvement, but hayloft sweepings were still occasionally spread on grassland to improve it—a doubtful benefit. Much draining done with tiles and with the "Government" money had been done too deep and too locally to dry out very restricted areas.

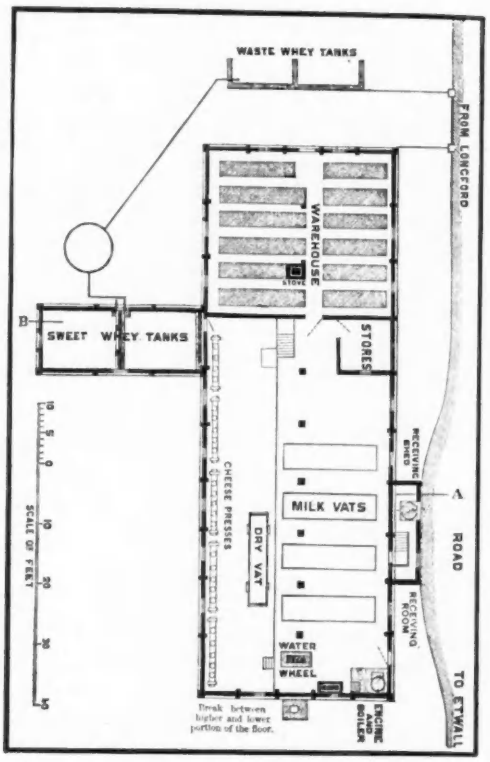

FIGURE 4.—The ground plan of the Longford Cheese factory laid out in accordance with approved cheese-making technique in America at the time. Cheese making was introduced to Derby to secure greater uniformity of milk production, ease of labor, and insurance of more stable prices. (From Jour. R.A.S.E. 1871.)

Indication of a general rise in standards of Derbyshire farming are just as nebulous as elsewhere. It may perhaps be accepted that cattle were better in the sense of yielding more milk and meat, that new fertilizers, feeding stuffs and implements were used in the county, and that a good deal of field drainage had been done; but no more than that can be stated with assurance.

III. Salop

Little real change took place in the farming of Shropshire between 1840 and 1880 although the new things were adopted by some farmers, implements, fertilizers and feeding stuffs, and some draining was done, but the general outline of the county's methods was described in almost the same words by Hanry Tanner in 1858 and J. B. Clarke in 1878. Ten years earlier William Pinches told the Select Committee on Agricultural Customs of 1848 that half the county had been improved in the previous 30 years—possibly an optimistic estimate. Pinches was president of the Wenlock Farmer's Club and owner-occupier of 400 acres. Despite his optimism he admitted that two-fifths of the farmers were poor men whose want of capital prevented their carrying out improvements and who were further deterred by lack of a system of tenant right compensation.

On a triangle bounded by the Severn and the road from Much Wenlock to Ludlow, a seven-course rotation was followed in 1858 but it included two years' fallow and ran wheat, clover, lent corn, fallow, wheat, pulse, fallow, and so was not so productive as it might have been. The land was heavily limed but guano was gradually taking the place of lime and part of the fallow was sown with roots dunged at 12 cubic yards. Vetch and rape were seldom seen. Twenty years before, wheat was the only cash crop but in 1858 some spring corn (barley) and some meat were sold. Haymaking was poorly done, few machines being used. Tanner thought the heavier land might advantageously be laid down. The cattle were a mixed lot, mainly Herefords, but some Welsh, Lancashire Longhorns, Shorthorns, Ayrshire and Devon, "mostly inferior." Some butter was sold in local markets and some young cattle were reared. Sheep and pigs were neglected but good horses were bred. Implements were cumbersome and antiquated but some new factory-make types were coming in.

In Corve Dale a modified four-course system was used, but on heavier land there was still some fallow which by 1878 was principally used for vetches. Some rape and roots were also grown. Hereford cattle were here found in perfection for beef though they were occasionally crossed with a Shorthorn bull. Grazing was rich and would fatten a bullock and carry two or three sheep an acre. There were many first-class breeders of Shropshire Down sheep, and horses were as good as in the wheat lands.

Light land in the south and west of the county was a thorough sheep farming district, showing extremes of good and bad management. The rotation was four or five course, some sainfoin was grown on the chalk, both Shorthorn and Hereford cattle were kept, though the latter were preferred; sheep were Shropshire Down, Southdowns having been tried but found to make the sheep too tender for their environment, and "few districts can produce a better collection of improved implements."

George Townsend Forester of High Ercall, Wellington, was farming 300 acres of arable land and 140 acres of grass in 1871. He was a leading farmer in Salop. His fences and ditches were in good condition. He had tile drained 273 acres with tiles supplied by his landlord and he used six and a half hundredweight of Proctor and Ryland artificials on his root crop (specification not now known). One-third of his roots were fed off by sheep, the rest being drawn for cattle. He sowed a seeds mixture of white and red clover, Pacey's rye grass, Alsike and Italian rye grass

for his ley. The farm carried a herd of 26 pure-bred Herefords for breeding, the produce being sold off at two and a half years, usually at Christmas. The cows were wintered on chopped straw and turnips, calves getting one pound linseed cake as well. About 150 Shropshire ewes were kept for breeding, dropping about 225 lambs annually. They were weaned in June and sold off annually, some ewe hogs being kept for flock maintenance. Eight plow horses and one jobber were kept.

Tanner's opinion that the heavier land ought to be laid down was shared by some other farmers and amongst these, H. Brown of Preston, Wellington; James Wetherell, Shimblecote, Much Wenlock and John Shuker of Chirbury had laid down substantial parts of their arable—Brown the whole of his—when Evans and Bowstead made their Report in 1875.

Naturally the county suffered severely from cattle disease and the wet seasons that terminated the period because it was part of the district with normally heavy rainfall. Cereal yields fell by half, and mortality among sheep was fantastic, some farmers losing their whole flocks. J. B. Jones, a member of the Council of the Royal Agricultural Society, of the Central Chamber of Agriculture and the Shropshire Chamber told the Richmond Commission in 1881 that he would have been better off if he had invested his money in the then relatively new North Western Railway rather than in farming. His sytem of farming his own land was fairly characteristic of the best in the county and not unlike that of George Townshend Forester already described. Sir B. Leighton, Bart., M.P. for South Salop, told the Commission a sorry story of the condition of the county resulting from wet weather and diseases of livestock beyond the control of the farmers. Conditions that were within their control had not changed very markedly. Possibly there were more good cattle and sheep; possibly there was better arable farming but of its proportion within the county there is no slightest indication and no possible quantitative measure.

IV. STAFFORD

Stafford is another county where dairy farming has been staple from time immemorial. By 1850 the Rutland plow with two horses had become fairly general and some two-furrow plows were used on lighter soils, while drills, horse hoes and other implements were ordinary. The old system of convertible husbandry had given place to the four-course, or some suitable adaptation of it and modern artificials were used. There was not much cattle breeding but a good deal of winter stall feeding from which the manure was counted as profit. The old Staffordshire sheep had been improved by crossing with new breeds like Southdown and Leicester and the native pig had also, despite the want of capital which prevailed on small farms.

Caird was greatly impressed by the very mixed type of farming and by the enterprise of some of the farmers, one of whom was making condensed milk from the produce of 30 cows and another manufacturing superphosphate of lime. One Hartshorne of Brancott had grubbed all his fences and laid out his farm in four fields of 100 acres each, for ease in working the four-course rotation. He collected all liquid manure for use on the grassland, kept 200 pigs which he folded on roots in winter and clover in summer, instead of the more usual flock of sheep, and kept them in the yard at night. Lord Hatherton had reclaimed 1,700 acres of Cannock Chase, drained it and worked it on the four-course system and carried upon it a flock of

2,000 Southdowns and a herd of 200 Herefords of which 80 were finished annually. Heavy dressings of dung and artificials were used under the eye of Mr. Bright, the manager, who had invented a revolving harrow, a furrow presser and a combined seed drill and roller. Caird estimated that 14,000 acres of the Chase could be reclaimed by his method. He praised Sir Robert Peel's farm but thought too many horses were used in the plows there.

Throughout the county the dairy was the farmer's mainstay except on a small area of land too light for grass. The old coarse Shorthorns with yellow skins had been improved by 1869 by crosses, but many of the farmers bred their own stock for herd maintenance, selling old barren and draft cows in autumn. Cheese was made all the year round but winter milk was used for suckling calves or buttermaking. Heavy land arable was entirely subsidiary to grazing and was cropped fallow; wheat; seeds for two or three years; wheat or oats. Three tons of lime an acre was put on land intended for permanent pasture and three-fourths hundredweight of bones on old heavy worn-out pasture after draining. A goodish seeds mixture of one quarter Yorkshire hayseeds, six pounds white clover, three pounds Alsike, two pounds Trefoil, one pound cow grass, two pounds rib grass, and one peck of Italian rye grass was used. Forty years before, no roots were grown on such land but mangolds, swedes and cabbage were being introduced on the best farms.

The light land area about Penkridge, Acton Trussell, Walton, Barwick, Shugborough and Heywood was farmed on a course of turnips, barley, seeds two years, oats, wheat. Lime was very generally used and bones and guano on the root crop and nitrate of soda as a top dressing on the cereals. A good deal of tile draining had been done near Uttoxeter and a steam mole draining outfit had been brought into the county from Essex to do contract work.

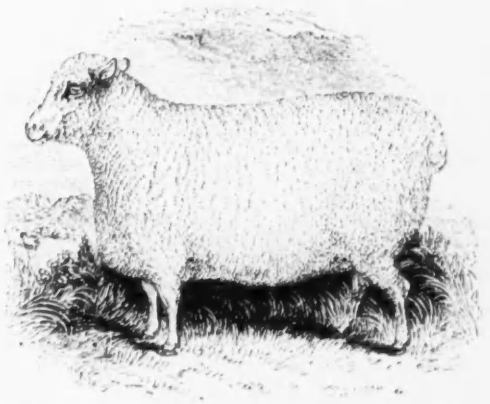

Figure 5.—A Ryeland ewe from Worcestershire. One of the strains which gave rise to a particularly advantageous cross between the Cotswold and the Ryeland. The flocks of Worcestershire were formed of Leicester, some Cotswolds, and the Cotswold-Ryeland cross. (Reproduced from W. Yonatt, Sheep 1837.)

A farmer who reckoned that he had largely escaped dread cattle diseases because he and his father before 1873 had run a herd of upwards of 100 dairy cows and bred their own replacements was W. T. Carrington of Croxden Abbey, Uttoxeter, who had 300 acres of which only 100 acres were arable. Most of his cows calved in March or April, the best and earliest of the heifer calves being reared on the mother's milk for two or three weeks at least and then weaned on skim milk and oatmeal or sweet whey and wheat or rice flour plus hay and oil cake "*ad lib.*" After three months, suckling was discontinued but still given a half pound linseed cake a day. The other calves were sold as dropped at about one pound a head. After calving the cows were given four-fifths of a pound of crushed corn or cake with hay or roots or grains until there was abundant grass for them. Carrington's opinion was that the "milking machines yet brought out, however

ingenious, have at present . . . entirely failed." He, like J. Carrington Smith, was an enthusiast for seeding down land on which high quality cereals could not be grown.

In 1871 Thomas Winterton of Alrewes Hay, Lichfield, had 408 acres of arable and 445 acres of grass which he used as a mixed farm for growing barley and wheat as cash crops and green crops for feeding and fattening store beasts and a small flock of Shropshire breeding ewes. Stores were bought in February and March and sold in August or September at the rate of 100–120 annually. The ewes produced an average of 120 lambs weaned in June and put on the freshest of the two-year ley with a cake supplement. The ewes were fed off annually and a fresh flock bought and in addition 800 or 900 shearlings were bought annually for fattening on turnips. Heavy dressings of new artificials were used and Winterton had bought two of the new Hornsby reapers.

Dairy farmers here, as elsewhere, came through disasters of the late 70's better than the arable farmers. They were said to be getting higher prices for cheese than the Americans, but in 1879 milk yields were low owing to bad weather. John Coxon of Freeford Farm, Lichfield, his own property for 36 years, managed Col. Dyott's estate and home farm and worked a farm at Elford with one of his sons and Pipe Hall Farm, three miles from Lichfield with another. He was owner of a celebrated flock of Shropshire Down sheep but the grassland was so wet that he was still in 1881 afraid to turn sheep out on it. On banks of the River Tame there had been 10 floods in 11 months: but light arable in the district was quite uninjured, the sheep and barley land that formed the greater part of Col. Dyott's estate. Formerly St. Michaels Lichfield had been nearly all market gardens growing vegetables and potatoes for the colliers and potters but that trade had entirely disappeared since the coming of the railways which brought foreign supplies. Conditions were the same round Tamworth and Rugeley. Similarly cheese making on dairy farms near Lichfield had nearly gone because the farmers could not get cheese makers, so the product was sold off as liquid milk. Moreover the Co-operative Dairy Factory had been given up for want of a good manager. Col. Dyott himself supported his house entirely by produce of his 325 acres of light land. He bought "nothing in the world but beef." The farm was essentially a sheep and barley farm on which no wheat had been grown 80 or 100 years before, but was now producing heavy crops of barley and yields of wheat 10 or 15 bushels an acre larger than the then current national average. Dyott was not altogether in agreement with the four-course system but his agent persuaded him to continue it, for the quite invalid reason "because it is what everybody does." He had tried mowing and reaping machines but was not greatly impressed by their economic advantage over the scythe. He had a fixed threshing machine.

In Staffordshire there is discernible perhaps a general tendency towards improved livestock, both cattle and sheep, and good horses were bred, while the Tamworth pig is a type of its own. There was marked desire to increase permanent grassland especially on heavy land that had been properly drained. Some of Cannock Chase had been reclaimed and otherwise as elsewhere orthodox improvements and novelties were being tried out here and there in the county by the open-minded farmer—but that again is all that can be stated, and it is quite indefinite.

V. Warwick

No very high opinion of Warwickshire farming was held in 1850. The county was predominantly devoted to grazing because it was heavy land and large farms were managed equally as well as those of other counties; but some farmers "stuck to some antique customs." Within living memory potatoes had been sown broadcast and then plowed in and the arable land was still in the old high crooked ridges, on which four or five horses in line were used at plow or harrow. Caird thought the land ill-drained and too much under the plow. The heavier land was under a bad rotation of wheat, fallow with a few turnips, wheat or barley; the lighter land grew peas and turnips, and had an occasional year's seeds as well, and guano and nitrate of soda were used. In the west of the county dairy farms still made cheese but found butter more profitable if near the towns. There was little specialization. Most of the farmers kept a dairy herd, some young cattle, and a flock of Leicester sheep. Bull calves were turned out fat at three, heifers kept for the dairy, and sheep sold fat at a year or fifteen months old. Most of the liquid milk market was regularly supplied by urban cowkeepers of whom there were 200 in Birmingham. Rham confirms all this, adding that the best soils were not cultivated so well as they might have been, far too much force being used in the plow, four horses where two would have been ample. Thorough draining, in his opinion, was in its infancy in the county despite being the birthplace of Elkington. Dairy cows were chiefly Longhorns crossed in every possible way, a miscellaneous collection indeed: but Shorthorns had been introduced and some Hereford and Scotch for grazing. Lavergne thought fertility was enhanced because of the large numbers of cattle kept and supplies of stable and dairy manure from the towns. He remarks that all the north had been at one time an immense moor, but half had become arable by the 1850's.

Ten years later heavy land was still worked on the wheat, bean, fallow system although light land was heavily worked for fallow and put down to one-year ley. Vetches were also grown. Charles Wratislaw's farm had been a retentive clay but by drainage and cultivation he had changed it into a very retentive loam, but still it remained only good enough to carry Welsh runts. He ran 51 beasts and 65 sheep on the pasture with 84 more sheep on the arable, worked six horses and kept four pigs for household use. His implements were a wagon, three carts, two iron plows with skim coulters, two wooden plows, one shut harrow, one for each of three-horse, two-horse and one-horse harrows, a scuffle, a wooden roller and a scuffle drill. On the lighter soils of the north he thought the four-course system could be used, as in fact a modification of it was.

The judges of the Royal Agricultural Society were disappointed because only five farms of over 200 acres in the county were entered for the prize competition in 1876. They complained that it was a very small proportion of the 7,000-odd holdings there. Lack of enthusiasm for the competition was perhaps reflection of labor troubles with Arch's unions in the early 70's, and bad weather in 1875 but it is more probably a reflection of stagnant spirit. The three prize farms were worked on much the same systems, one of them being Clopton Farm near Stratford-on-Avon occupied by Henry Stilgoe. It comprised 333 acres arable and 150 acres pasture, and was worked on a six-course rotation of swedes, mangolds or rarely turnips;

barley; seeds; wheat; beans or peas; wheat or barley. Roots got 15 tons dung and when singled, two hundredweight nitrate of soda. Half were fed off, half drawn for yard fed beasts. Stilgoe ran about 80 head of cattle finishing about 46 annually. He had eight dairy Shorthorns and reared about 20 calves annually, of which he bought 12. He had tried a Longhorn bull but speedily changed back to Shorthorns. He kept about 140 Oxford down ewes, drafting in 40 shearlings annually and had 190 lambs in 1876. He also bought in sheep, fattened and sold them off. He kept four large White sows and sold off progeny as weanlings at one pound a head. He kept nine working horses, and occasionally had the help of a Fowler's double engine plow especially in breaking up two-year ley. The other two prize farms were much the same except that they took catch crops which Stilgoe never did. They are all examples of pretty good farming, similar in type but not on so large a scale as the farm of 930 acres within three miles of Alcester which Heming Bomford had been working for 47 years when he described it to the Richmond Commission, March 23, 1881.

As elsewhere there were some farmers who were putting land down to grass, a very reasonable thing to do on the heavy lands. Finlay Dunn of Weston Park, Shipston-on-Stour estimated that half the south of the county was in permanent pasture in 1875, the lighter land towards Oxfordshire being arable, and R. Caulcutt of Barford had begun laying down in 1869 and had done 200 acres out of a farm of 450 acres of which 350 acres was formerly arable. A single instance is no basis for generalization, but the tendency was definitely present. On trying to sum up this not very definite body of evidence, however, it rather looks as if progress in Warwickshire might not have been so rapid as in some other counties but it is merely an impression rather than judgment of carefully weighed facts.

VI. WORCESTER

Though there were some large farms in Worcester most were small in 1850, and consequently many new implements then recently invented were only slowly coming into use. However, a two-wheel plow rather like the Rutland was fairly common, and in the Vale of Evesham the old heavy swing plow was giving way to a lighter type with one or two wheels and in very light lands a horse-drawn double furrow was to be seen. Turnips, barley, clover, potatoes, wheat formed the rotation on richer land but bare fallow was still necessary on heavier soils although longer rotation than the old wheat bean course had been adopted. It was wheat, beans, barley, clover, and seeds for three or four years ley broken up for oats. By 1850 rye was grown only for early sheep feed or for cutting green to soil cattle which were none too startling. The beasts were mainly Herefords and South Wales with some Shorthorns, and injudicious crossing had failed to improve them. Flocks were Leicester and some Cotswolds and a cross between the Cotswold and Ryeland. The large black cart horse was bred. Hops and orchards were characteristic of the county, the former being very productive about Kidderminster, but the orchards planted too closely to get the best results.

One of the big farms at Little Comberton had been formerly four farms containing 1,100 acres. It was occupied by Francis Woodward who described the county to the *Select Committee on Agricultural Customs* in 1848. He emphasized the good results that had been secured by field drainage. On his own land tile drainage costing three pounds

an acre had enabled him to raise his wheat yield from 24 bushels to 48 an acre. He could grow turnips where it had been impossible before, and the land carried one-third more stock. Woodward knew land that carried 500 sheep in place of 100 before it was drained. About a quarter of the county had been done by 1848 and the rest was slowly being done. Another method of improvement he had practiced was to pare and burn the land for vetches for feeding off to sheep with a cake supplement. In the result he got 48 bushels of wheat an acre the following year. Potatoes were grown in the county for Birmingham and carrots for the same market on the Wolverley Sands but some of them were used for feeding horses.

There were several other large enterprises of similar scale in the county, and indeed still are today, farming of the Bomford family, for example, having become more or less classical. In 1869 Benjamin Bomford occupied a total of 1,360 acres at Pitchell, Tilesford and the Grove, mostly strong clay and all cultivated by comparatively new steam-hauled implements. Bomford owned two of Fowler's 14 h.p. double engine sets. Both heavy and light lands on the farms were in high state of cultivation and said to be cleaner than many gardens. The grassland was carefully managed and arable cropping arranged to get as much sheep feed as possible on the Pitchell light land, catch crops being introduced into a four-course rotation: heavier land was cropped on a six-course like that described by Rham. On the latter the best possible use was made of machines, Smyth's steerage drill sowed wheat for example, but no reaper had yet been bought. Naturally heavy dressings of artificials and cake feeding were integral parts of the system. About 140 Shorthorns were kept for breeding and feeding, some 30 being bred annually, the remainder bought as required and worked off gradually during winter and spring. In May they were turned out to summer on pasture. Some 400 ewes, cross between Cotswold and Hampshire Down put to a Hampshire Down ram were kept, 100 being drafted yearly. About 60 Yorkshire pigs and 30 horses for cartage completed the account of the livestock. They are enterprises typical of high farming.

Ten years later the Bomford enterprises had expanded enormously and Ernest Bomford of Spring Hill, Fladbury, was able to tell the Richmond Commission that he farmed 1,000 acres of his own and 4,000 acres of his father's, the latter having begun with 170 acres and gradually added to his holdings. On his own farm he grew hops, potatoes, barley and wheat, the rest principally wheat, barley and beans. On his own farm he had 150 beasts, 850 sheep and 20 horses. His father's land carried 300 beasts, 2,900 sheep, and 80 working horses and there were five double sets of steam cultivating machinery there besides one on his own farm. Reaping machines were used and horse hoeing was done. Benjamin Smithin of Dumbleton near Evesham who also gave evidence to the Commission farmed a total of 1,390 acres in three occupations. Charles Randall of Chalbury farmed 570 acres and acted as Land Agent for some 50,000 acres, had been mowing by machinery, and stacking by elevator and thought use of machinery had slightly reduced his costs but he was convinced that the only way to combat the depression was to grow other than ordinary farm crops.

These men were all of the kind that gave our farming its world-wide reputation then, but even Worcester was not exclusively farmed by such men. Clement Cadle acknowledged that he had

seen some of the best within his experience but he also saw some of the worst he had ever seen. Some parts of the county were famous for butter and cheese in 1867 and there were 46,000 cattle and 204,000 sheep grazing on its pastures then. More the horses had been greatly improved in the previous ten or fifteen years. Grassland, like farming, varied widely. The upland was poor stuff and was being plowed up for arable. The riparian grassland on the Avon was very good. Old high ridges of some of the arable that had fallen down made the use of mowing and haymaking machines and horse rakes difficult. Orchards were famous but many were neglected. Hops were improved.

The tendency to lay down land to grass, which was apparent in the other grazing districts and indeed pretty generally throughout the country, had not appeared within 20 miles of Evesham where farms were mainly arable devoted to growing wheat as the main crop if Charles Randall of Chadbury referred to above is to be believed, and in 1875 he could say that there was no need so therefore "we go on as before." On the 2,940-acre estate of Robert Woodward of Arley Castle near Bewdley only about 150 acres had been laid down because the tenant farmers were not attentive enough and had not sufficient capital to make it a favorable change for them. They could not afford to wait for the return and grass requires capital to stock it. On the other hand Thomas Oldaker of Whitfield, agent to Rev. Archer Clive who owned 1,100 acres had been laying down since 1860 but not much, only 41 acres having been done mainly near woods subject to much game and on a thin light soil.

Worcester was a county in which there were many great enterprises and where also there were many comparatively backward farms, of limited acreage. The weight of influence exercised by owners of the great enterprises may well be overestimated because sight of such very rich and successful farmers possibly disheartened men who found it impossible to compete with them; but if no more can be said the county was certainly one where some of the foremost farmers in the country were operating on high farming methods during the period.

VII. HEREFORD

Hereford is, of course, much like Worcester, and in 1850 was more in grass than in tillage. Rotation in the valleys and less exposed sites was wheat, turnips, barley, clover, wheat, peas or vetches. Wheat was carefully cultivated but turnips not so well. There were hopyards in the middle and east of the county, in the hundreds of Broxash, Radlow and Grimsworth. Orchards were numerous and cider making general. Hereford cattle were justly celebrated but there was no dairy, milk being given to the calves. Oxen were formerly worked at three and four and fattened at five years old but in 1850 were fed at two and sent to market before three, graziers from the South and Midlands buying them in at the October and Candlemas fairs. The pure Ryeland sheep was extinct, its place taken by a cross between it and the Leicester breed. Farm horses were bred in considerable numbers and riding and coach horses on the borders of Radnor and Salop. Pigs were usually obtained from Wales as were eggs and poultry, at Kington market and sold to dealers for the large towns Cheltenham, Gloucester, etc.

Only about a quarter of the field drainage necessary had been done by 1848 but its value had been proved. Wheat gave only eight-thirteenths

Figure 6.—Herefordshire Harvest Scene in the beautiful rolling country of the western Midlands, a prosperous and highly productive agricultural section of old England, where a rather diversified agriculture was carried on successfully, and still is. (By courtesy of the Trustees of The Tate Gallery.)

bushels on undrained land but rose to 26 after the work had been done, some eight bushels more than the estimated county average. The wet heavy clay grassland only gave five hundredweight hay, an impossibly low yield, and ought to be plowed out and cropped, the best method being to pare and burn for turnips followed by wheat, barley, roots and seeds. Henry Higgins reckoned that half the sward in the county could be dealt with profitably in this way. He himself farmed 870 acres near Hereford of which 600 acres were arable.

Lime abundant in the county had formerly been used to excess, but by 1853 new artificial manures had lessened the evils of too heavy and too frequent liming. Size of the farms in the county was considered to be larger than the average elsewhere and the system of cotting sheep early made for good buildings. Young stock were kept in orchards so that the trees benefited from the manure. Part of the cattle were fattened on the riparian meadows and green crops and part sold as stores. Only near Ross was the old Ryeland sheep still to be found. The arable then was held back by the insufficiency of manure, only farmyard manure being possible because bones were scarce and expensive, and the prime cost, transport, and frequent adulteration of superphosphate and guano made them less popular than they might have been. Field drainage and adequate supply of artificials were all that was required to make the county, the purest agricultural district in England, rank on an equality with any other whatever: but demand of the Midland graziers for Hereford stores tended to make breeding the most prominent feature of Hereford farming.

Hereford cattle had been famous for nearly two centuries then, and careful breeding by men of capacity and capital had made them into one of the finest

beef breeds in the country—perhaps in the world—and by the mid 19th century the lower price of good Herefords as compared with Shorthorns brought the best blood, and consequently a good class of animal more within the tenant farmer's reach than good cattle were elsewhere, or so it was claimed. The breed indeed was commonplace from Montgomery in the north to Glamorgan in the south and spread eastwards through Worcester and Hereford. They were slow in maturing and the much appreciated "marbled" quality of the beef was thought only to be obtainable after several seasons. The oxen were good workers and were used in Wiltshire as well as Hereford for a year or two before being finished. There was a big trade in stores to all the grazing districts and an export trade to the New World was developed. The story of the development of the breed belongs to an earlier period than that being dealt with here and has often been told.

In what was perhaps an excess of local patriotism Thomas Duckham of Baysham Court, Ross, declared that the county was pre-eminent amongst the counties of England for variety of its agricultural production in 1865 and under skilful cultivation very generally attained to considerable eminence, a real necessity for the inhabitants because in the absence of minerals, agriculture and wood formed the county's only wealth. Since 1800 introduction of folding sheep on roots had enabled the Ryelands, the sandy loam about Ross in the hundreds of Greyton and Wormelow, to yield abundant crops of wheat on the four-course system, although he himself thought a five-course better. Artificials were used on roots and yard manure on wheat. He was keen on compost and collected road scrapings, sidings, fold-yard manure, lime and salt to make it. He had a reaper and a mower, Howard's tedding machine, Fry's American gatherer and Kell's horse rake—so was an up-to-date farmer.

On heavy soils the rotation was longer and included some fallow on which vetches were sometimes grown. It was on such soils that the choicest cider was made and most of the hops grown. A few steam cultivators had then recently been introduced but the small fields and crooked hedgerows were against them. One set was owned by Hawkins of Sugwas Court and there were contractors. Davis of Lenton had worked for Horlick of Woodend with good results and Taylor, the bailiff to Lady Foley, hired plant from Drinkwater of Madley; but the efforts made to establish a limited liability Steam Ploughing Co. in the county had so far failed although one had been formed for manure especially phosphates. No particular change appears to have been made between 1865 and 1878. There is little or nothing in all the evidence to guide judgment in assessing the developments that had taken place in Hereford during the four decades. Perhaps it is true to say that Herefordshire farming had always been superior and that it continued to maintain its standard.

VIII. GLOUCESTER

The Cotswolds and the Vale have always formed a natural division of Gloucestershire and in 1840 Drinkwater S. Haywood of Frocester Court who had farmed there for 30 years and whose family had been there for generations had 400 acres of his 500 in old pasture. Here dairy farming was the universal pursuit. The light, sandy soil produced a sweet herbage in constant pasture for sheep and young beasts; the whole farm had been drained and the heavy soil produced abundant herbage of the richest quality. Farmyard manure mixed with earth and ditch scourings

was used once in two years on the mowing ground. One hundred cows, a cross of Gloucester or Alderney with a Shorthorn bull, were kept and a good Hereford bull was also used. Thirty heifers were weaned annually to maintain the herd and thirty old cows culled. The cows were turned out to grass in April or May, divided into three lots each having two fields which were grazed a week alternately, great care being taken not to overstock. Some 300 sheep were kept and pigs were kept on whey, summer grass and green crops. Produce of the dairy was made into cheese as it had been time out of mind.

A man of the same name, possibly a relative, one Jacob Hayward of Beverston Farm, Tetbury, occupied 1,300 acres at the same date. An area of 220 acres was thin wet clay formerly plowed but then all in grass, probably since 1820, and was of little value, being pastured by young beasts. A dairy of 40 cows, a cross between Wiltshire Longhorns and Gloucester, was kept and 20 heifers bred yearly as well as six Hereford ox calves being bought. A flock of 440 breeding ewes, crossed Cotswold and Leicester was kept, some being fattened on the farm and 200 old ewes and 200 wethers sold annually.

On the arable the rotation usual in the district was followed. It was turnips, barley or oats, clover mown, clover sheeped till July and then plowed for wheat, barley or oats, winter vetches, roots, etc. Implements used were the Beverston plow invented by Mr. Tugwell in the late 18th century, a short one-wheel plow made of wood; indeed wooden moldboards on the adhesive soil were still common. Somerville's double furrow plow, an early 19th century adaptation of the old Hertfordshire type depicted in Walter Blith's *Improver Improved* 1653, was used for the second stirring of turnip land. Iron plows were too costly and difficult to get repaired.

H. Scott Hayward, a descendant of Drinkwater, was tenant of Frocester when the Richmond Commission sat in 1881 and the farm was still two-thirds pasture and one-third arable. It was some of the best land in the Vale of Gloucester and had been held by the same family on a yearly tenancy since the middle of the 18th century. It was farmed on much the same lines.

The Cotswolds had nearly all been broken up by 1850, having been used for sheep grazing for centuries, and by means of paring and burning and liberal use of artificial manure moderate crops were obtained though turnips were very chancy. The ordinary rotation was turnips or swedes, barley, seeds mown for hay, seeds fed, wheat usually drilled. Sainfoin, a common and old-established fodder crop, was grown normally under oats. Haymaking was excellent but sheep were the mainstay though most farmers kept six to 15 cows, rearing calves and buying N. Wilts beasts as stores. Young beasts were grazed in summer with sheep on second-year seeds, then in yards on hay and straw, there being but few turnips. Heifers were sold in-calf to dairymen at three and steers broken to work at the same age, draught oxen being common. The sheep were improved Cotswolds and New Leicester cross; horses were improved Black cart horses crossed with Flanders.

The farming of the county as a whole was typified in these two descriptions of the Vale and the Cotswolds, and much the same remained true in 1878 when T. H. Halbert of South Cerney won the Royal Agricultural Society's first prize for a Cotswold farm. He occupied 1,268 acres, of which 200 was pasture, carried a herd of 12 cows, four bulls, 10 in-calf heifers and two weanling calves at the time of inspection, as well

as 88 steers and fatting beasts. His flock of pure Cotswolds comprised 323 breeding ewes, 188 ewe tegs, and 387 tegs. He had 13 breeding sows and in January 125 store pigs. The work was done by 24 horses and a set of steam tackle which did contract work as well. His crops that year were 200 acres wheat, 90 acres barley, 140 acres oats, 20 vetches, 18 mangolds, 12 Thousand headed kale, 80 swedes, 35 turnips. The second prize was won by William Arkell, Jr., Hatherop, Fairford, who farmed 710 acres on much the same lines.

First prize in the dairy class was won by A. J. Steele, Red House Farm, Stratton-on-the-Fosse, who carried on a farm of 168 acres pasture and 55 arable, 46 cows in calf in January, three barren cows, 11 two-year-old heifer calves, 13 yearling heifers, 13 weaners and two bulls. The farm was devoted to production of cheese, calves being sold at a week old except about 12 of the best which were kept for herd maintenance. The flock was 117 West country down breeding ewes and three rams. Seven breeding sows were kept and a large quantity of pork produced. The arable was on the four-course and only three working horses were kept. Second prize was awarded to George Gibbons of Tunley Farm which comprised 248 acres pasture and 100 acres arable. It was managed on the four-course system and just as heavily stocked. Other farms described do not differ greatly and judges report that they were uniformly well managed and it was difficult to decide to whom to award prizes.

The county did not escape some of the effects of the prevailing tendency to laying down land to grass, but E. Bowley of Siddington House, Cirencester admitted that he had laid down the land near the house because he preferred to look at grass rather than fallow. A more practical reason, the great expense of working heavy clay and the hope of keeping dairy cows, caused William T. Drew of Twigworth Farm, Gloucester, to do the same. He selected for the purpose well-drained clean land in high maurial condition and found it satisfactory. His old pasture had been much improved by feeding cows, sheep and pigs with cake, corn and roots and by dressing with fine bones, super-ammoniacal manures and farmyard manures. Wet years a little later emphasized the necessity for such action. Thomas Arkell of Lechlade told the Richmond Commission in 1881 that he had been the tenant of two farms totalling 580 acres since 1838 on one and 1851 the other. He declared that he would not have a clay farm as a gift; much of that type of land must be laid down; but W. J. Edmonds of Southrop Lechlade, a pioneer of steam cultivation, once a member of the Council of the Royal Agricultural Society, an occupier of 1,900 acres mostly strong land, but not including much pasture, did not entirely agree with him although the millers had refused to buy wheat from heavy land in 1878 because it was not good enough, a condition he had never experienced before.

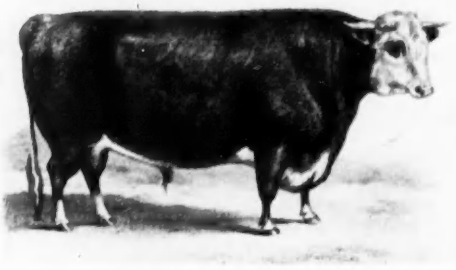

FIGURE 7.—The famous Hereford stock, with its long straight back and massive build and distinguished by the white face and head has become one of the standard breeds of Taurine cattle in the temperate lands of the world. One of the very best beef breeds of cattle. (From *Farmers' Magazine*, 2nd Set, Vol. XI, March 1845.)

IX. Oxford

Any definition of the farming of Oxford is difficult because of its variety. Lavergne found every kind of crop there in 1847, every sort of land, all grades of rent and every method of cultivation. Rham thought that yield had doubled and that there were better implements, e.g., improved cultivators and hoes, since Young's day but too many horses were still used at plow though the horses were in fine fettle. There were, however, still a few ox teams. Some of the old high ridges of the old days were being plowed down and a modified four-course system introduced. Turnips, formerly broadcast, were drilled in 1850. He was enthusiastic about the sainfoin grown on the chalk hills but considered that the meadow dairy farms ought to have their old worn meadows plowed out, cropped, and laid down again. The cattle were various, Devons, Alderneys and a few improved Shorthorns, fat calves being sent to Oxford and London. Similarly early lamb for Oxford was produced from the flocks of Southdowns and the New Leicesters kept on the best grass. Green crops were carefully cultivated for sheep and the Berkshire pig was famous, enormous boars being raised, although Rham thought 10 sc. pigs would probably be more profitable than those of 20–25 sc. then bred. Caird estimated yields in the east of the county at 28–32 bushels wheat and 40–48 barley while round Woodstock they dropped to 20 wheat and 40 barley. Rents in the West were too high, and since the Duke of Marlborough had refused to reduce them many men had to give up farming so that the Duke found himself with 5,000 acres in hand. Farmhouses were large and comfortable and provided with good kitchen gardens and orchards.

Five years later Clare Sewell Read described the county in much the same terms, remarking that there were still some open fields on which were grown wheat, oats, beans or clover, wheat—no turnips and no fallow. On the Chilterns and to the North of Oxford a four- or five-course was followed and the root break got liberal dressings of superphosphate and farmyard manure. On clays bare fallow for wheat was necessary although some vetches were grown. Meadows were constantly mown and never manured so Rham's opinion that they should be plowed out and cropped before re-seeding was doubtless justified. There was still a dash of the old Longhorn in some herds and the Dutch breed had been introduced round Woodstock, but Read thought them "no acquisition to any locality." What would the British Friesian breeders of today say to that? Evidence of unprogressive farming was the old two-wheeled plow "with rampant beam resting on standards" and drawn by oxen, which had been condemned nearly a century before by Arthur Young; and on the clays a swing plow with a wooden moldboard nearly as ancient in design, but, what Read may not have realized, easier to use in the soils, or so it was argued, than iron plows. Some of Howard's iron plows had, however, found their way into the county. Wooden harrows were still in use although there was a variety of horse hoes and cultivators.

The Crown began clearing its allotment of Wichwood Forest in January 1858. Ten miles of public roads 30 feet wide were made at a cost of 700 pounds a mile, the deer were killed off and the timber cleared, many of the smaller trees being pulled down by Fowler's tree throwing machine, a profit of 16,500 pounds being made on the timber. Roads were fenced with dry stone walls and seven farms laid out with whitethorn quicks. A measure of the work is

that before disafforestation the rental of the land was 1,813 pounds 7 shillings 6 pence and after a net expenditure of 10,452 pounds 10 shillings the rental of the old and new farms had risen to 5,104 pounds 7 shillings 6 pence.

Only a poor entry of 21 farms was made for the R.A.S.E. prize competition of 1870, but the poor seasons and crops were taken to be a complete explanation of this. Mrs. M. E. Millington of Ash Grove Farm, Ardley, who farmed 820 acres arable and 70 acres pasture got first prize. Her system was what might be expected on such an enterprise. The farm was worked on a strict four-course, the roots being drilled on the flat and turnips getting three hundredweight super, swedes four. The crop was horse-hoed three or four times. Only 120 acres of wheat was sown on land mucked at 10–12 loads an acre. The seeds were rolled in with a Cambridge roller, clover only being used once in eight years, a mixture being sown in the alternate seeds year. Two reapers were used. Only a few young steers were kept in summer but 70 beasts were wintered in yards with a few roots and some linseed cake and if they paid for the cost of the cake that was all that was expected. The manure was profit. Four hundred Lincoln ewes were lambed and in good turnip seasons about 200 sheep were bought for winter feeding. About 80–100 pigs were kept, a few being fattened annually but they did not get much attention nor did they play much part in the economy of the farm. Eighteen horses were kept. Second prize was awarded to Treadwell of Upper Winchendon near Aylesbury where he occupied 180 acres arable and 240 acres grass and his farm was worked on a six-course rotation, his main business being a dairy of 50 cows used to produce butter for London like other farms in his neighborhood. The judges considered his a good example of "high farming." Third prize went to Chipping Norton and farms at Adderbury near Banbury, and at Faringdon were commended.

Meadows must have been improved between 1850 and 1878 when Joseph Darby thought abundance of meadows and pastures the county's greatest glory, but no new crops had yet been introduced to the stiff soils from the Chilterns to the northern boundary of the Oxford clay, and clays round Faringdon, Burford and Oxford were falling down, but a large amount of poor pasture in the district had been broken up before 1858 by paring and burning, and some of it was once again being laid down. In general a four- or five-course rotation was practiced in the district and vetches, trefoil and rye was grown on the fallows. A deal of contract steam plowing was done here by 1878, two-furrow plows made by Cook of Lincoln were widely used, and reaping and mowing machines had been adopted. Cattle were Shorthorn and sheep Oxford Down. The Cotswolds were, of course, still devoted to the sheep and barley husbandry, and the same might be said of a wide district including Witney, Woodstock, Chipping Norton, Moreton in the Marsh, Stow on the Wold, Northbury and Burford according to one A. T. Matthews who supplied information to Darby. The best part of the county was then the district including Great Tew, Bloxham, Adderbury, and north of Banbury, but wet stiff lands in the center of the county were not worth occupying rent free. Farming of the Chilterns had not changed except that largely by the efforts of Mr. Matthew Savidge supported by J. H. Langston, M.P., of Sarsden House and backed by Lord Sherborne and his tenant Thomas Game of Broadmoor and others, a

better type of Shorthorn beast had been developed and a cross between the Oxford Down and Cotswold sheep had improved flocks. Some new implements were also being made in the county, Gardner's turnip cutter at Banbury; a famous Corn Dibbler by Newbury of Hook Norton; Huckvale's turnip hoe and revolving knives for bunching out, and steam tackle and reaping and mowing machines were widely used.

Clearly there were progressive farmers in Oxfordshire as there were all over the West Midlands but the number of great enterprises, as one might expect in a business which is still comprised predominantly of small units, was limited. In some counties there was a larger number then in others and their example consequently more obvious, but improvements in the grazing and dairy counties were mainly in such imponderables as better grassland and more productive animals, no measure of which was then possible. The arable all along the limestone and chalk hills was as improved or as improving as it was in other similar districts.

REHABILITATION OF TRANSPORTATION IN WESTERN GERMANY

Jack A. Bradley

BEFORE the war Germany maintained a strategic position in the field of transportation. Central European countries depended upon passage through Germany for both imports and exports. Since the war, the occupying powers have been faced with the problem of making Germany's transport system available again for national and international trade. The Potsdam Protocol directed that restoration of the German transport system should be one of the first objectives of the Control Council, but transportation rehabilitation has been greatly complicated by the zonal division of Germany.

While preparing for war, Germany established one of the most complex and best-equipped transport systems in the world. After the Nazis came to power, the Ministry of Transport eventually assumed complete control over all phases of transportation. Owing to the centralization, the government was able to promote transport co-ordination. For military purposes electrified railroads were paralleled with steam facilities. An elaborate inland waterways system crisscrossed Germany in all directions. A plan was implemented to cover the country with super highways known as *autobahns*.

In "normal" years seasonal fluctuations of both passenger and freight traffic was similar to that of the United States. Freight traffic was lowest in January and February. A sharp rise in spring was followed by continued increase to an October peak. In November and December freight traffic declined sharply. Passenger traffic was lowest in January and February with a vacational peak in July and August, and a holiday peak at Christmas.

The German transportation system is dominated by a nationally owned system of railway lines, known as the *Reichsbahn*. Prior to the war, the *Reichsbahn* handled about 73 per cent of all freight traffic of the country, as compared with 3 per cent handled by privately owned railway lines, 21½ per cent by waterway carriers, and 2½ per cent by highway vehicles. In the passenger field the *Reichsbahn* carried about 70 per cent of all passenger traffic, privately owned railway lines about 3 per cent, and motor carriers about 27 per cent, much of which was purely local hauls.

Breakdown of transportation was undoubtedly one of the most important factors causing final collapse of Germany. Transportation facilities were not chosen as strategic bombing targets until late in 1944. After that decision, their vulnerability soon became apparent. Air attacks were concentrated on waterways and railways in western Germany, which were closest to our air bases. In final stages of the war only military movements were possible, and they were by no means dependable.

Immediately after cessation of hostilities, repairs were accomplished by cannibalization of damaged stock and the utilization of available repair stocks. Such resources were quickly exhausted,

and new supplies and materials have fallen far short of requirements. Transportation has been the bottleneck in many cases of agricultural and industrial recovery.

The occupying powers agreed that long distance highway transport would be restricted for security reasons and that the main burden of German traffic would fall on railways and inland water-

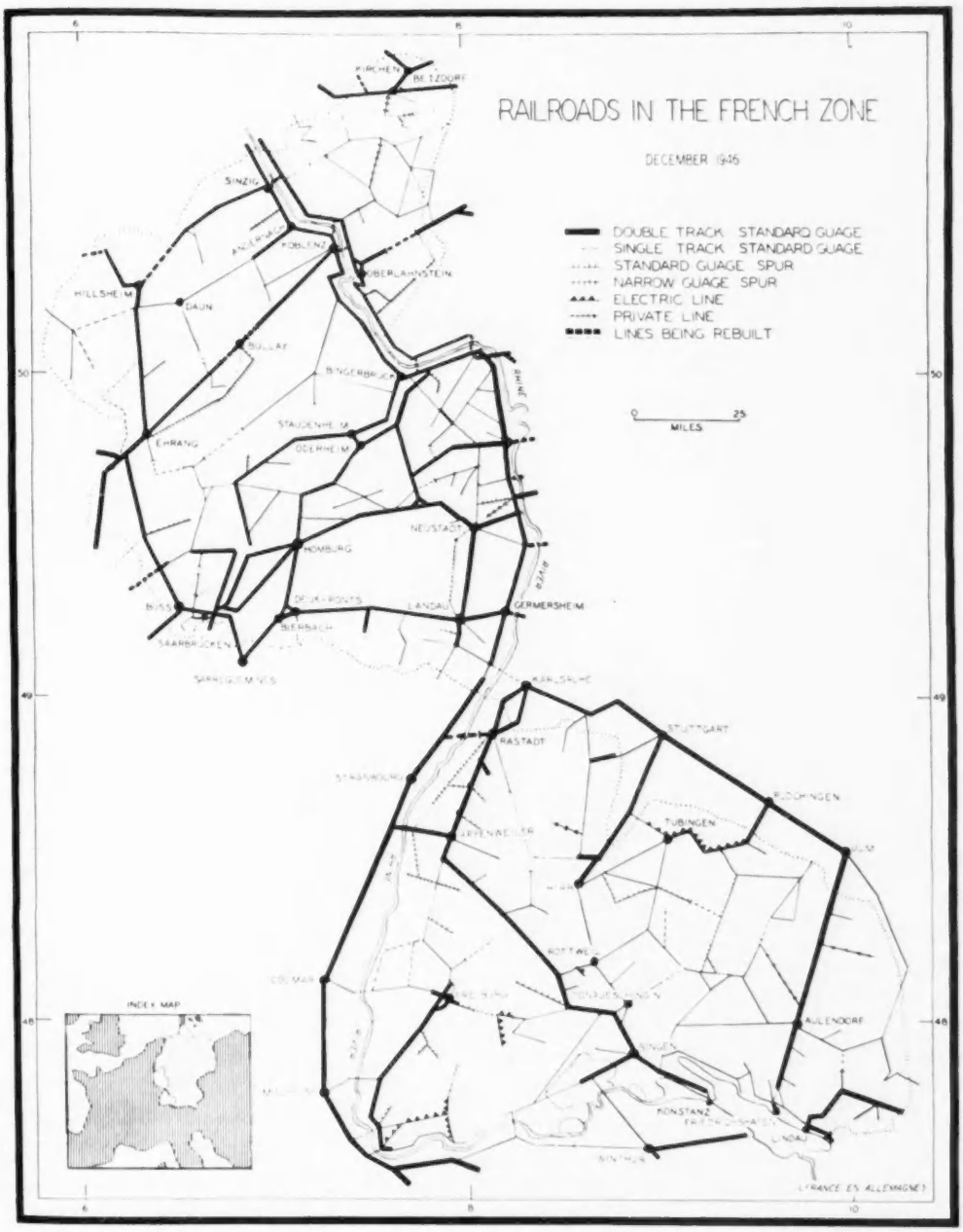

FIGURE 1.—Railroads in the French Zone account for approximately one-tenth of the total German trackage. French economic self-interest has spurred the repairs.

ways. However, many short distance highway hauls have been necessary to facilitate essential transport.

As industrial and agricultural recovery gain momentum, increased burden is placed upon transport. When repair parts and new stock are not available, every effort is made to secure more efficient utilization of existing facilities. Usually repairs lag behind proposed schedules, and facilities must be removed from service because of excessive depreciation.

THE RAILROADS

The railroads were, and remain, the core of Germany's transportation system. In prewar years railroads of Europe (excluding Russia) moved about a billion metric tons of cargo annually. Germany's railroads carried about 45 per cent of the total. In 1937 the Rhineland-Westphalian district shipped 45 per cent of Germany's total railway freight.

Germany possessed the greatest concentration of railway network in Europe, a total of 56,000 kilometers of track, 119 kilometers of track per 1,000 square kilometers of surface, or 90 kilometers of track per 100,000 persons. The German railway network was more than four times as dense as that of the United States. With incorporation of lines in Alsace-Lorraine, Luxemburg, Austria and part of Poland in 1944, the *Reichsbahn* increased to 78,980 kilometers of track.

During the war Russia and the Allies agreed that eastern Germany would be subject to Russian policy, both during the war and the occupation. Therefore, eastern Germany was little damaged by Allied bombings. The area contains eight of the total 31 *Reichsbahn* (national railway) divisions, which would indicate that the Russian Zone contains approximately 25 per cent of Germany's railroads; and they have suffered far less damage than those in western Germany.

According to the census in November 1945, the three western zones contained a total of 16,761 locomotives, of which 7,430 were usable. (In 1938 the same area had approximately 18,000 locomotives.) The French Zone contained 2,034 locomotives, of which 1,113 were usable. The American Zone contained approximately 8,200, of which 2,600 were usable. The British Zone contained 6,500, of which only one-half were usable.

In the three western zones there were 44,250 passenger cars, of which 17,950 were usable. The French Zone contained 4,214, of which 2,410 were usable. Of a total of 427,700 freight cars in the three western zones, only 396,000 were usable. The French Zone contained 48,505, of which 35,082 were usable.

The French authorities do not believe that they received a fair share of the rolling stock. One-fifth of the total area of western Germany is in the French Zone, but their share of the rolling stock is much less than this fraction.

The French Zone contains 5,677 kilometers of track, which is approximately one-tenth of the total length in Germany. By January 1946 only 60 per cent of the lines were in operation, but by October 1, 1946 repairs had raised the total usable length to 5,219 kilometers, or approximately 92 per cent of the total (see Figure 1). The rugged terrain in the French Zone complicates the reconstruction of the railway network and retards the speed of traffic. Railway spurs are numerous, but they move only a small amount of traffic at very low speeds.

Most repair shops in the French Zone were demolished. The French Zone contains only light repair shops with

14,200 skilled workers. The American Zone contains 32,000 skilled workers in 104 *Reichsbahn* shops, and 18,000 skilled workers in 22 private repair shops. Thus the American Zone is able to keep more equipment in better repair. As a result, the French Zone moves only one-third as many trains as the American Zone, and over one-fourth as many train kilometers.

Railroad rehabilitation in the French Zone has been spurred by economic self-interest. Whenever possible the railroads in the French Zone are being integrated into the railway system of France. Many main lines were repaired first for purely economic reasons, without regard for the total program for Germany. It has been estimated that Rhine bridge repairs in the French Zone will require several years. At present, railroads in the French Zone are forwarding coal and wood to France.

FIGURE 2.—In the British Zone the *Reichsbahn* is carrying twice the prewar monthly passenger totals. This added traffic has resulted in deterioration almost exceeding repairs.

In the British Zone at beginning of the occupation there were 7,590 miles of railway, of which only 656 miles were in operation. In July 1946, 7,363 miles of railway were in operation, but traffic was still far from normal (see Figure 2). There were only two connecting points with the railroads of the Russian Zone. A trip from Berlin to Hamburg, a direct distance of 160 miles and a prewar trip of three hours, required ten hours in July 1946.

At beginning of the occupation there were 1,319 demolished railway bridges in the British Zone, and no permanent bridges existed over the Rhine. By November 1946 about 1,100 bridges were repaired or reconstructed. The most important achievement was building three long-span bridges of one-half mile each over the Rhine. German engineers and workmen did the actual work, but British engineers planned and directed.

At beginning of the occupation, number of locomotives in the British Zone numbered less than half the normal necessary number. All were in poor condition, because they had received little attention and repair during the last months of the war. The passenger coach total was 12,000, of which 5,000 were a total loss. There were 200,000 freight cars, but only 136,000 were immediately usable. By the end of 1946 a total of approximately 160,000 freight cars were in operation.

The *Reichsbahn* is the most used system of transportation in the British Zone, due to absence of highway transport. Average monthly passenger movement is about 57,000,000, as compared with a prewar monthly average of 30–35,000,000. Large increase of passenger journeys is result of movement of displaced persons through the zone

and readjustment of population within the zone. Movement of freight within the zone at the end of 1946 amounted to 8,800,000 tons against 1,100,000 tons carried in June 1945, as compared with a prewar monthly average of 8,200,000 tons. The increased traffic can be handled only by constant overloading and overcrowding.

During 1947 approximately one-fourth the total freight cars in the American Zone were unusable. Almost one-quarter of the passenger cars and three-fifths of the locomotives in the American Zone were out of service. At first glance it would appear that few repairs were being completed, but in reality rolling stock became unserviceable at a rate almost exceeding increased rate of repairs. During the winter repairs were restricted by inclement weather, while deterioration increased rapidly. Although the Bizonal Area contained more repair shops than the French Zone, it became necessary to send some locomotives to Belgium for repairs and some freight cars were repaired in Czechoslovakia.

During 1947 the Bizonal Area showed a loss of 50,000 freight cars, of which 12,500 were listed as the net car debt of the Soviet Zone. One shipment of 100,000 head of cattle was sent to the Soviet Zone from the American Zone in exchange for sugar and molasses, but the exchange was not repeated because the Russians did not return the cattle cars. The car debt tended to increase until goods were exchanged on a car-for-car basis.

Material shortages have been acute for the railroads. The following figures for the Bizonal Area during the first half of 1947 will serve to illustrate the situation. Only 50 per cent of the steel and less than 35 per cent of the wood necessary for repairs were received. Because a negligible amount of paint was received, excessive deterioration of rolling stock followed. Only about half the glass needed for signal devices and windows in cars and shops was received. Many locomotives became unserviceable due to lack of asbestos for firebox packing. Asbestos is not produced in Germany, and has been ordered from the United States, Great Britain, and Canada. Less than 30 per cent of the necessary amounts of rubber, leather, textiles, and electric light bulbs were received.

FIGURE 3.—The American Zone contains the densest railroad network in western Germany, and all repairs are hindered by the lack of steel.

There are 28,199 kilometers of track in the American Zone and 67,596 switch units (see Figure 3). About 495 kilometers of track and 1,860 switch units wear out or corrode annually and need replacement. Due to lack of steel only 88 kilometers of track and 478 switch units were laid in the year ending June 30, 1947. A total of 24,500 workers are necessary for maintenance work, but absenteeism reduced the average number available to 15,500. Personnel

suffer from lack of protective clothing, food, shelter, and even soap. At the end of the war 885 of the 10,168 railway bridges in the American Zone were unusable. By June 1947, 600 of them had been returned to service, so that 98 per cent of the bridges were usable. Most of the unrepaired bridges are the larger ones, the repair of which will require excessive amounts of steel and material.

Authorities of the American Zone have encouraged utilization of railways for trade with other areas. Export traffic from the American Zone includes potash to Belgium and the Russian Zone, salt to Czechoslovakia, timber to Britain, as well as normal reparation and restitution goods to various foreign countries. Imports include fresh fish, potatoes, and barley from Denmark, coal from Czechoslovakia, and potatoes from Poland. Slow unloading of cars and border inspections cause excessive delays at ports and border points. Railroads are also burdened with many short-distance passenger hauls.

THE INLAND WATERWAYS

In Germany sea and railway transport are supplemented by canals and rivers, rather than by motor trucking as in the United States. Inland waterways are well adapted to the movement of bulky freight, therefore, they are able to relieve the railroads of many heavy cargoes. Prior to the war inland waterways carried approximately 60 per cent by bulk of all exports, and 25 per cent of the ton mileage moved by all forms of transport. Coal represented 35–37 per cent of the total freight moved by the inland waterways, ores 15–17 per cent, building materials 20 per cent, metals 4–5 per cent, and fertilizer 2–3 per cent. Remainder of the freight consisted mainly of agricultural products.

Total freight moved by inland waterways was approximately 26 billion ton-kilometers, while railroads accounted for approximately 80 billion ton-kilometers, due to longer average distance of waterway shipments as compared with railway shipments. Generally 60 per cent of total inland waterway tonnage was handled in the lower Rhineland, where heaviest traffic moved from Holland and Belgium to Hanover and Berlin.

In January 1938 the inland waterways equipment had capacity of 6,453,000 metric tons. Self-propelled craft accounted for 627,000 tons of the total. After incorporation of Austria, 510 bottoms with capacity of 275,000 tons were added to the total. In general, barges with capacity of 1,000 tons were favored as the standard type.

In 1939 total length of inland waterway routes was approximately 13,000

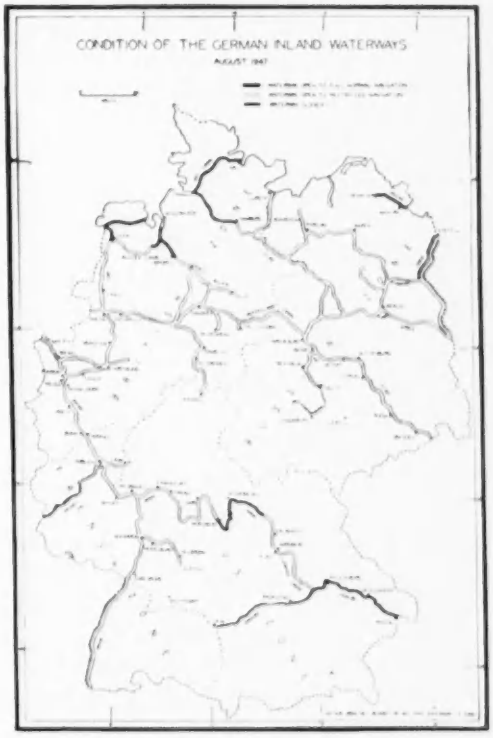

FIGURE 4.—Numerous canals connect the navigable rivers and the resulting network is capable of handling the bulk of heavy freight.

kilometers, of which 7,500 kilometers were canals. Foundation of the network is navigable rivers, tributaries of which are joined by canals. One great disadvantage is lack of a natural focus (see Figure 4). The canals were not constructed according to any over-all plan, and consequently varied with reference to the size of barge that could be accommodated. Future plans call for the standardization of canals to accommodate at least 1,000 ton barges. A 1,000-ton barge can move as much cargo as 100 ten-ton freight cars (the usual German size) at average speed of seven kilometers per hour.

The British Zone contains the greatest concentration of inland waterways in western Germany, and for this reason received the brunt of the allied air attack from British bases only 450 miles distant. The French and American Zones do not contain extensive waterways and bomb damage was proportionally less, but repairs are handicapped by swift currents and fluctuating depths. Canals and waterways were hit hardest at their locks, where great damage was done in small areas. Generally speaking, waterways did not suffer as much damage as the German railway system.

In the British Zone at the time of occupation only 60 kilometers of navigable waterways were in operation. Since that date the Rhine, Weser and Elbe Rivers have been returned to service, together with many canals. There is a total of approximately 1,835 kilometers (about 1,150 miles) of navigable waterways in the British Zone. Opening of inland waterways in the British Zone involved clearance of 520 miles of canalized waterways, clearance of 526 damaged bridges, and removal of 40,000 tons of steel debris. By July 1946 there were 2,917 barges in operation with a carrying capacity of over one million tons, and also 524 tugs. By August 1947 water transport in the British Zone had not reached half of its prewar index.

Retreating German forces damaged or destroyed many bridges, barges, and facilities. They destroyed 36 permanent bridges across the Rhine, 11 of which were in the American Zone. Also in the American Zone 30 bridges were destroyed on the Main, 36 on the Neckar, and 33 on the Danube.

Rehabilitation of waterways has been greatly encouraged, because the occupying powers agreed that waterways have less war potential than other forms of German transport (see Figure 4). In February 1946 various civilian companies and agencies in the American Zone were given responsibility for operation and maintenance of waterways. By July 1946 all primary waterways in the American Zone were again in operation and the Rhine was established as an international waterway. Approximately 1,300 barges and 250 tugs were in operation, and more than 12,000 tons of cargo daily were moving by water transport. Freight moving down the Rhine from the American Zone was mostly gypsum, iron ore, gravel, cement, stone, and coal.

In October 1946 barge service was inaugurated between Berlin and Bremen, permitting ocean vessels to unload directly into barges, thus relieving overburdened railroads. It resulted from over a year's work in clearing sunken bridges along the route, and represented the successful climax of negotiations between the British, American and Russian authorities. Also in October 1946 the first barges moved down the Rhine from Karlsruhe loaded with timber for export to Britain.

In the American Zone waterways were closed by ice in December 1946, and were not opened completely until March 1947, thus placing an added

burden on the railroads. Ice destroyed several bridges in both American and British Zones. During summer of 1947, water level on all rivers dropped very low, and again much shipping had to be diverted to railroads. During such periods of drought railway traffic also decreases due to lack of hydroelectric power available for electrified lines in the south. On the Danube, water level dropped to the lowest height recorded since 1826. Inland waterways are an uncertain means of transport at all times, due to floods, droughts, and ice, but it would seem that 1946 was an especially bad year.

THE HIGHWAYS

Prior to the war approximately 213,000 miles of highway existed in Germany, but they constituted only a very minor part of the total transport facilities (see Figure 5). The German government had subordinated highway transport in order to avoid competition with the *Reichsbahn* (national railways). Because prewar highway transport organizations had been strongly influenced by the Nazis, they were abolished. Independent trucking for local hauls is encouraged by the occupying powers in order to avoid centralization of transport organizations.

In Germany national highways (including double-lane autobahns) constitute less than 20 per cent of the total road mileage, while state and county roads account for most mileage. In November 1945 the British, American, and Russian Zones each contained slightly less than 30 per cent of the total German highway mileage, while the French Zone contained slightly more than 15 per cent. The most severe war damage resulted from destruction of bridges, which have, for the most part, been replaced with temporary structures or detours. Although bombs did not greatly damage roads, lack of maintenance caused extensive deterioration of surfaces.

Need for highway transport became crucial after the war, when railway and inland waterway transport were handicapped by destruction of their fixed routes. Highway transport had to replace them until their fixed routes could be repaired. As direct result both highways and motor vehicles suffered from excessive deterioration. Emphasis was placed on local hauling and long distance traffic was curtailed.

As capacities of railways and inland waterways increase, highways will be less utilized. Highways are a definite war potential and never again will Germany have a highway system that might be utilized for military purposes. German super-highways are of prime importance as present supply routes, but as military potential their future has not yet been definitely decided. Due to excessive depreciation, rehabilitation of highways will be slow.

The existing highway transport system of Germany has estimated capacity of more than two billion kilometer-tons annually, which should be adequate for the approved essential German economy. Utilization of existing facilities depends on German ability to supply new vehicles, tires, and spare parts.

An early survey revealed that only 22 per cent of the German trucks in the American Zone were usable. In February 1946, American authorities approved release of 12,500 army vehicles to essential German transport. In summer of 1947 the British Zone authorities began negotiations for release of 20,000 of their army vehicles to the Germans. By September 1947 freight movement on highways in the American Zone had risen 53 per cent and passenger traffic 48 per cent. By October 1947

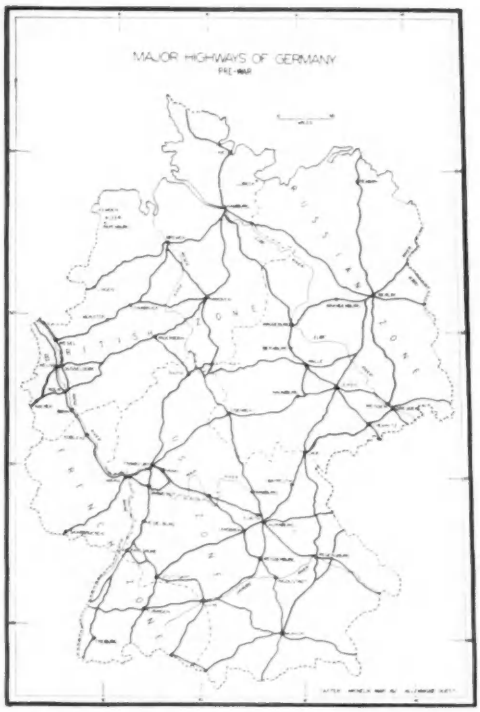

FIGURE 5.—Highways constitute only a minor part of the transportation facilities of Germany. Prewar highway traffic was purposely subordinated in the interests of the national railways.

number of operable trucks in the American Zone had risen to 80 per cent of the total of 81,765 licensed cargo trucks. Similarly 70 per cent of the 120,000 licensed trucks in the British Zone were in operation.

When urgently needed, military units of the Bi-zonal Area have been authorized to use many of their trucks to assist in harvesting and hauling firewood. In July 1946 the first ton-and-half trucks were produced at the Opel plant in Greater Hesse in the American Zone. In September 1946 the Daimler-Benz plant at Mannheim was producing three-ton trucks at the rate of 250–300 per month. Critical shortages of fuel, spare parts, and tires continue to paralyze truck transport of Germany.

During the first half of 1947 less than 15 per cent of requirements of tar, asphalt, cement, wood and timbers necessary for highway construction in the American Zone were received. The shortage represents the situation throughout Germany. Because Germany lacks asphalt and tar, prime essentials of road repair must be imported. At least 35 per cent of the highways in the American Zone need repairs or are unusable.

CONCLUSION

Since beginning of the occupation, transportation has been one of the critically weak spots in rehabilitation of German economy. Western Germany contains coal reserves which are essential to economic recovery of Germany and western Europe. At present transportation systems of the area are hard pressed to distribute available coal and other products. It will be of little value to raise industrial and agricultural production, if transport capacity is not raised correspondingly.

At present, transport facilities are carrying the maximum load possible under existing conditions. Among steps taken to increase efficiency are: permitting only essential movements and shipments, more passengers or freight moved per car, more cars per train, and decreased turn-around time. It would appear that transport systems are operating on a very slim margin of safety, and such intensive utilization of facilities is causing increased depreciation at a rate exceeding repairs.

Immediate needs of the highways and railways appear to exceed present availability. Germany particularly needs railway rolling stock, of which there is deficit throughout Europe and the rest of the world. Highest practical priority should be given to supply of steel and other materials necessary for repair and construction of railway rolling stock and highway vehicles.

In July 1946 the Quadripartite Railway Committee agreed that uniform through-traffic rates should apply in all zones of Germany, and that equal distribution of revenues should be made between zones on the basis of services performed. At present through-traffic service is in operation from southern Germany to the North Sea, but the east-west traffic is still halted at the Russian Zone border. Border delays considerably reduce availability of rolling stock and vehicles. While artificial political boundaries exist in Germany, a complete rehabilitation of transportation does not appear possible.

Transport systems of western Germany have been completely denazified, and it is hoped that present personnel will remain relatively stable, both in numbers and dependability. Transfer of authority to a civilian chief in the Bi-zonal Area on July 1, 1948 will not greatly affect the transportation rehabilitation. German authorities will continue to exercise such powers and controls as the occupying powers assign to them. The occupying powers will continue to exercise only a broad, general, policy review on all matters except budget, finances, new construction, and rate structures. The four items are subject to detailed supervision, and must be approved before being placed in effect.

Long-range plans of the occupying powers include expansion of transport facilities to carry 25 per cent greater load in 1951 than in 1938. Extensive use of diesel-electric locomotives and larger freight cars are most important improvements planned for railway transport. Prior to the war Germany planned to standardize her inland waterways for accommodation of 1,000-ton barges. Waterways do not constitute a direct threat as military potential, so the occupying powers will encourage maximum practical rehabilitation of waterways, to the subordination of railway and highway transport. To relieve the present overburdened railways, highway transport will be encouraged and expanded. As a security measure highway transport will be closely supervised, and only essential movements and shipments will be authorized. As long as Germany is occupied, autobahns and other highways will not be utilized for any purposes not essential to economic recovery.

Much will have been accomplished when seasonal fluctuations of weather do not disrupt transport systems, but complete rehabilitation of German transportation will depend upon three major accomplishments: first, there must be physical restoration of transport facilities, especially railway rolling stock and locomotives; second, artificial political boundaries must be removed to permit unrestricted flow of passengers and freight through all parts of Germany; and third, there must be gradual removal of controls, that the transportation systems will be completely directed and maintained by competent, trusted German personnel.

AGRICULTURAL LAND USE IN IOWA

Helen L. Smith

THIS study shows, by means of statistics worked out in maps, some fundamental aspects of geography of the state of Iowa. County figures from the Sixteenth (1940) Census Report on Agriculture were used in making the accompanying isarithmic maps showing major land use patterns of Iowa. The county is the smallest unit for which agricultural data are published, but county data are fairly satisfactory for Iowa because the 99 counties are relatively uniform in size and shape. The maps on which this study is based portray areal extent and relative importance of certain crops. Iowa, lying as it does in the Corn Belt, except for the northeastern corner, is fairly homogeneous and probably shows less local variation in physical environment and in the corresponding land use pattern than other Corn Belt states.

All counties of the state are high in percentage of land in farms, ranging from 84 to 99 per cent (Map I). Such high percentages reflect a landscape in which land is naturally productive. In general, a scene of prosperity and well-being prevails. The census figures reveal that both the western third and the northern third of the state have more than 95 per cent of land in farms. Thus, only one or two per cent of the land surface remains for urban use, roads, parks, and forest land in some counties. Areas with less than 90 per cent of the land in farms occur in three parts of the state—central, northeastern, and southeastern, the latter two bordering the Mississippi. In this connection, a brief survey of the topography, urban land use, and soils sheds some light on the interpretation of the agricultural land use pattern of the state.

Topography plays a major role in accounting for the allocation of farm land in Iowa. In the parts of the state enclosed by the 95 per cent isarithm, there are few relief features; gently rolling lands mantled with glacial drift stretch away as far as the eye can see. In the rest of the state, undulating plains drained by meandering streams and bordered by scattered hills promise an ever changing landscape. The areas of greatest local relief are in the northeast and southeastern portions of the state and correspond with two of the three "less than 90 per cent" areas on the map. The northeastern area, a part of the Driftless Area, is the most scenic in the state. Iowans are proud to call it the "Switzerland of America." More than 6000 acres of this land is being taken out of cultivation to be reserved in state parks, forest reserves, and a national monument. The southeastern area has been dissected by the lower courses of the Des Moines, Skunk, Iowa, and Cedar rivers as well as the Mississippi.

Urban land use accounts for the third of the three land areas on Map I showing the lowest percentage of land in farms. Des Moines, in the south central part of the state, is the largest city (population 159,819). Other towns over 40,000 in population include Sioux City,

Davenport, Cedar Rapids, Waterloo, Dubuque, and Council Bluffs. None of these, however, are large enough to show up on the isarithmic map made on a county basis.

The obvious correlation between the pattern of soils and the proportion of land in farms is very striking. On Map II, showing some of the principal soil association areas of Iowa, soils developed under grass correspond with areas of highest percentage of area in farms on Map I. These prairie soils were formed not only under the characteristic natural vegetation but also on a somewhat characteristic parent material or combination of parent materials: namely, (1) the Mankato till (late Wisconsin) in northwestern Iowa, shown on the map as Clarion-Webster soil types (CW), (2) the Iowan till of northeastern Iowa, from which the Carrington and Clyde soils have been formed (CC), (3) the Kansan till, from which have been formed the Shelby, Tama, and Muscatine soils (TM, SMT, and SSW) in the south central, southeastern, and southwestern parts of the state. The Marshall (M) and associated soil types of western Iowa are dominantly prairie soils, those of the extreme northwest being chernozem-like. Since the prairie soils are on the more level areas of the state, topography as well as parent materials and natural vegetation has been a dominant factor in each "association" area. The broad bottom lands of the Missouri and Mississippi Rivers are chiefly loessal soils. In southern Iowa, the Shelby, Grundy, Haig, and other types are dominantly prairie soils and planosols. Planosols are soils with strongly leached surface horizons over claypans on nearly

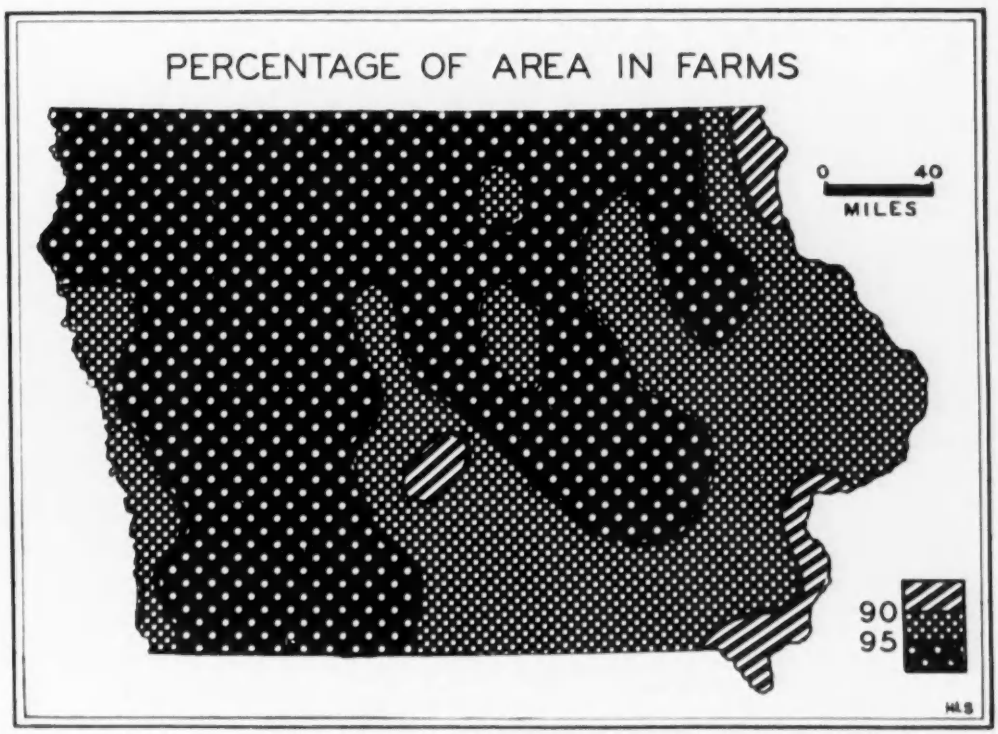

FIGURE 1.—All the counties of Iowa rank high in the percentage of land in farms, those of the west and north being highest. Even in the three areas with the lowest percentage less than 16 per cent of the area is occupied by uses other than agricultural.

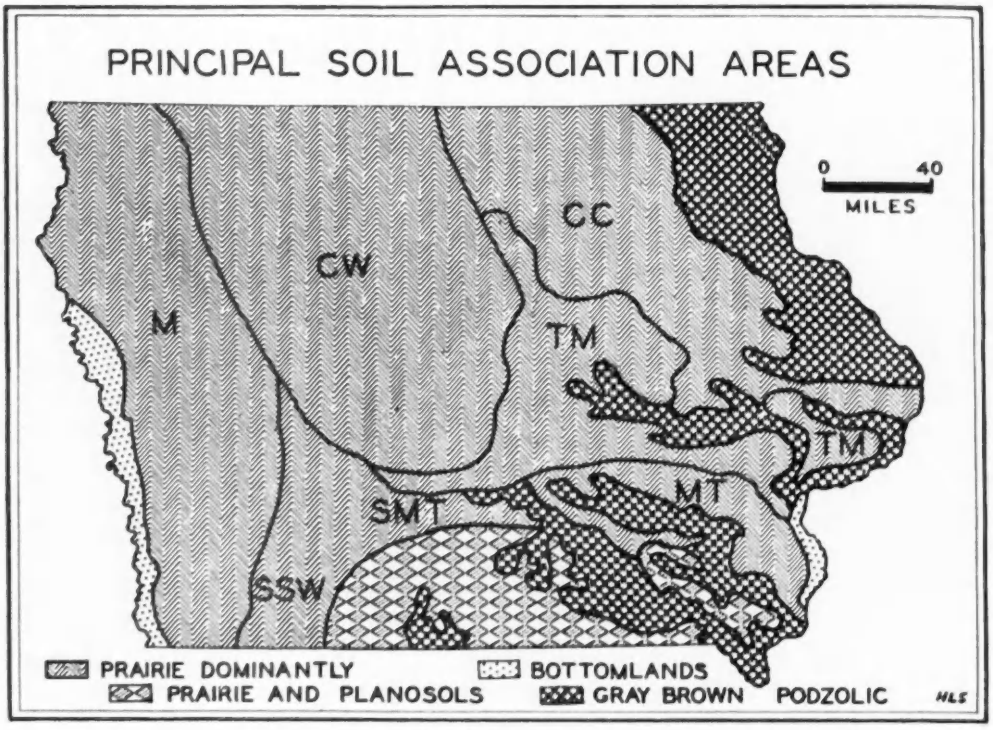

FIGURE 2.—Prairie soils cover most of the state, while soils developed under forests occupy the more hilly lands of the east and southeast. (Based on Soils Subsection, Iowa Agricultural Experiment Station, *Key and Description of Some Major Upland Soil Types of Iowa*, May, 1946.)

flat land developed under either grass or forest vegetation. (Yearbook of Agriculture, *Soils and Men*, 1938, p. 991; Yearbook of Agriculture, *Climate and Man*, 1941, p. 277.) In eastern Iowa there are areas of gray-brown podzolic soils formed, of course, under forests and on land that is quite hilly. Fayette, Clinton, Lindley, and Weller are examples of these soils. Succeeding maps, which show land use for specific crops, in several instances display the close relationship between this soil pattern and crop distribution.

The next three maps indicate the pattern of land use devoted to forest (or woodland), to plowable pasture, and to crops respectively. These are the three major divisions of farmland as given in the Census.

The percentage of farmland in woodland (Map III) is low over the whole state, ranging from less than one per cent in the western part of the state to 20 per cent in the northeast. The census defines woodland as "All farm wood lots or timber tracts, natural or planted, and cut-over land with young growth which has or will have value as wood or timber." It must be remembered that originally the natural vegetation of the state was prairie grassland except along the streams and the northeastern Driftless Area, where hardwood forests predominated. Naturally, these forests contributed to the development of podzolic soils. Because of the thorough dissection in this part of the state and along the major streams, land is unsuited to tillage with power machinery and so has been left in woodland and natural pasture. On the more level prairie lands of the state where the lowest percentages of woodland

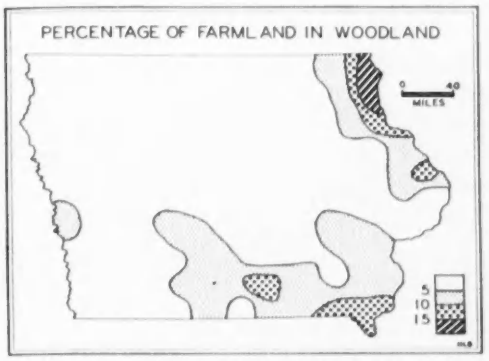

FIGURE 3.—Of the three major divisions of farmland (woodland, plowable pasture, and crops) woodland occupies the least amount of land in all counties.

occur, trees have been planted on individual farms as windbreaks and sources of wood. The similarity of pattern between this map and Map I, where highest percentages of area in farms corresponds with lowest percentage of farmland in woodland and vice versa should be noted.

Plowable pasture (Map IV) has the greatest concentration in the southern counties, where most serious erosion occurs. The census definition of plowable pasture is: "Land used only for pasture in 1939 which could have been used for crops without additional clearing, draining, or irrigating. (Land from which a crop was harvested in 1939 but which was later used for pasture was [not] included. . . .)" Geographers might prefer to identify plowable pasture as rotation pasture. Probably much of the present plowable pasture land of the southern half of the state was formerly used for cultivation and then was retired as erosion proceeded to the point where cultivation was no longer profitable. Wiser land use would have kept these lands in permanent pasture. This map does not, however, indicate the presence of the great

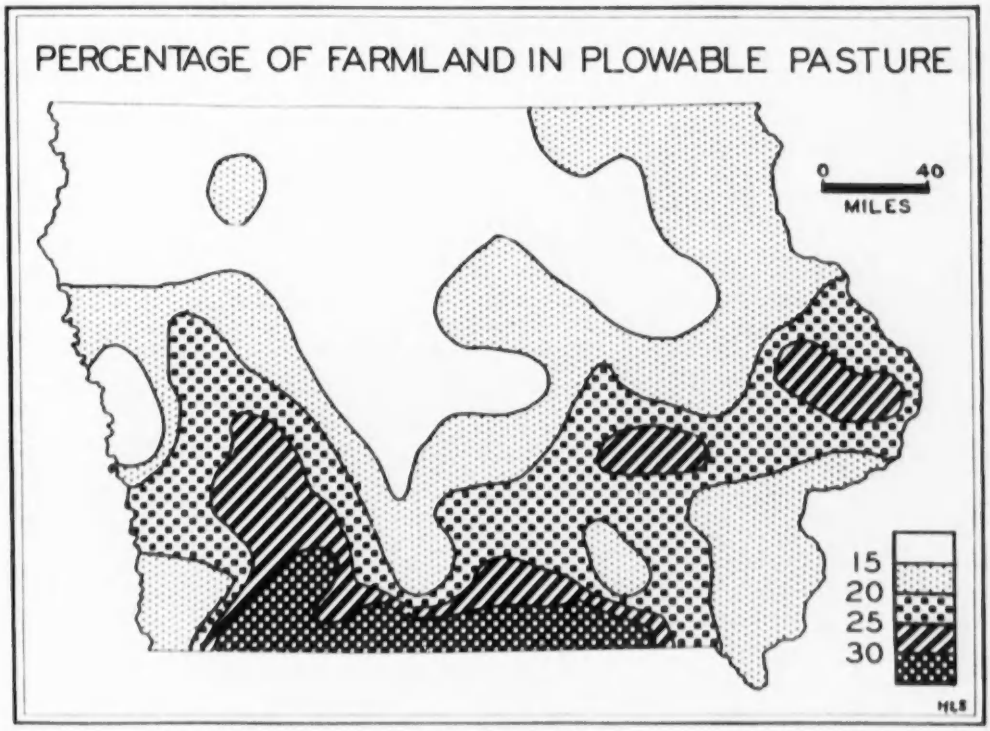

FIGURE 4.—Percentages of farmland in plowable pasture vary from ten in the northwest to 38 in the south showing a greater range than that for woodland, but preserving basically the same pattern of distribution.

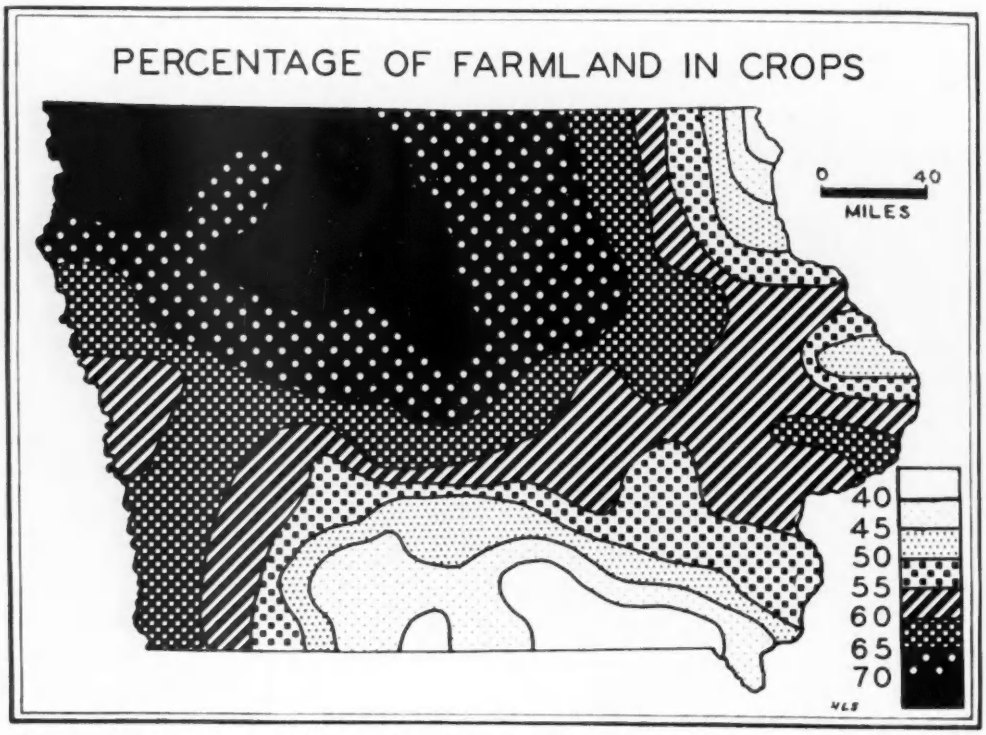

FIGURE 5.—While the distribution of cropland shows an even greater range of percentages than for woodland and plowable pasture, the great amount of arable land in all counties is an important characteristic of the land use pattern in Iowa.

amounts of permanent pasture in the hilly lands of the northeastern part of the state. No map was made to show permanent pasture because statistics were not available. In the three census years previous to 1940, "woodland," which was shown on the previous map, was divided into three classes, one of them being "woodland pasture." In the 1940 census, data for woodland was obtained as one total. However, the next map (Map V) showing percentage of farmland in crops may be interpreted thus: the hilly lands of the Driftless Area, shown by less than half of the farmland in crops, are devoted largely to permanent pasture.

On Map V, the highest percentages of farmland in crops (77) are shown in the northwest-north central part, an area of concentration which correlates with the Wisconsin Drift. The most general characteristic of Map V is the steady decrease from the northwest to the southeast (35 per cent) and to the Driftless Area of the northeast (38 per cent). Doubtless, topography and its associated soils play an important role in this pattern. Probably the most striking fact shown on this map is the high percentage of arable land all over the state. Fifty-nine per cent of the total farm land of the state is in crops, a percentage that compares with that of Illinois (59 per cent) but exceeds that of other states such as Indiana with 49 per cent, Delaware with 43 per cent, Mississippi with 38 per cent, Virginia with 23 per cent, and Florida with 21 per cent.

The succeeding six maps throw most light on man's occupance and use of the land for the major Corn Belt crops—

namely, corn, oats, wheat, barley, hay, and soybeans.

Acreage, or areal extent, rather than yield has been used in compiling all the maps which show crops. These maps indicate the per cent of cropland in that particular crop.

Of course, everyone knows that corn is the most important crop in Iowa. Just how high is the proportion of cropland in corn and how much does the amount of land planted to corn vary from one part of the state to another? Furthermore, in what areas is corn dominant over all other crops combined and what is the intensity of the lead? Census figures show that corn occupies 45 per cent of the total land in crops and 27 per cent of the farm land of the state. Although a high percentage of cropland devoted to corn—the highest for any single crop—prevails on Map VI, there is some variation in density. For instance, Lee County in the extreme southeast has 34 per cent of its cropland in corn, while Fremont County in the extreme southwest has 62 per cent. In other words, twice as many acres of corn per unit of cropland would be observed in Fremont County as in Lee County. Also, a percentage of 62 means that Fremont County has nearly twice as many acres of cropland devoted to corn as to all other crops combined. Corn is exacting in weather requirements. A hot, moist growing season, particularly in July and August, with hot summer nights is essential to high yields. During the period of its most rapid growth corn takes water from the soil at a faster rate than any other field crop of the region. The deep, fertile prairie soils of the western part of the state combined with the more level topography are well suited for corn. No doubt, the nearness of the southwestern portion of the state

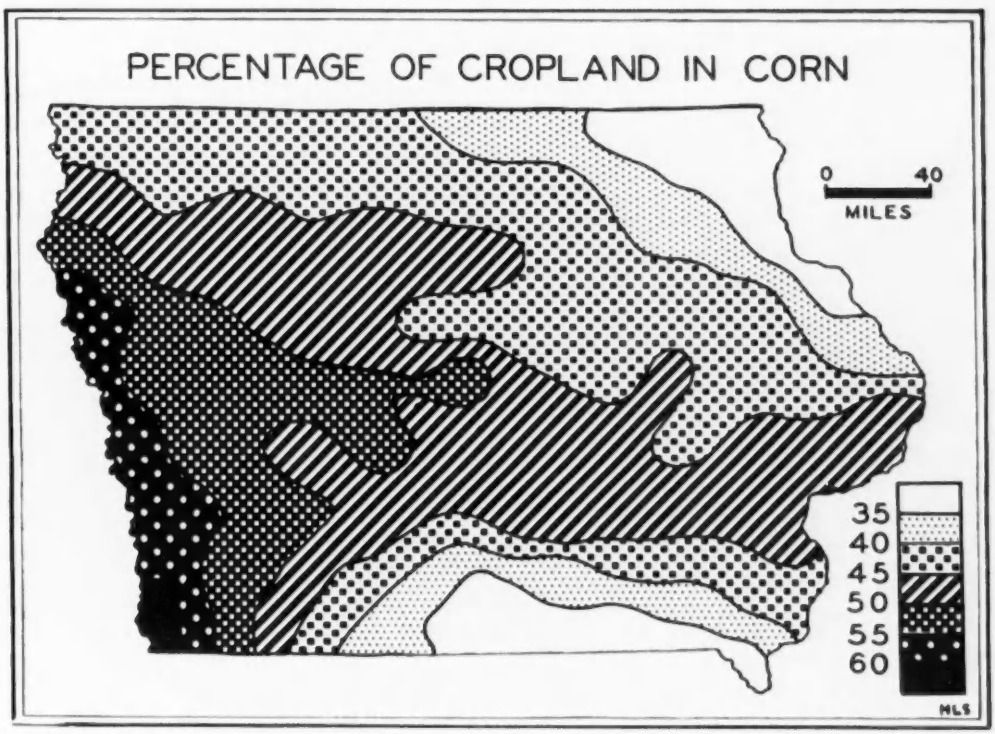

FIGURE 6.—In the southwest the amount of cropland in corn excels that of all other crops combined. Although high percentages prevail all over the state, there is some variation of density.

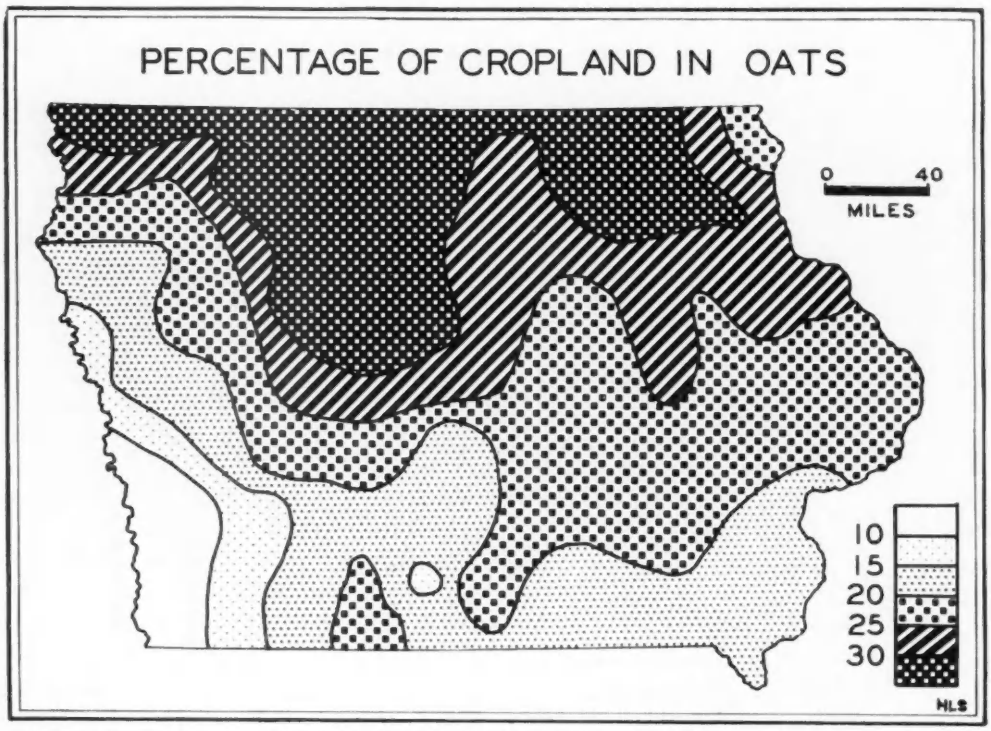

FIGURE 7.—Oats production is concentrated in the northern part of the state, where competition with corn is less because of the higher latitude. All percentages are lower than those for corn.

to Omaha, a great meat-packing center indicates the importance of economic as well as natural factors in the pattern of land use for corn.

Oats has its greatest areal extent in the northern and cooler latitudes of the state. The range varies from 6 to 37 per cent over the state (Map VII). Competition with corn and other crops is probably a factor in the lower percentage of the southwestern part of the state.

In the percentage of cropland in wheat (Map VIII) and the percentage of cropland in barley (Map IX) the land use pattern shows a concentration in the western portion of the state, but all percentages are low, 14 and 12 per cent respectively being the highest. Spring and winter wheat acreages were combined before the percentages were computed because both amounts were small. However, a plotting of the figures for winter wheat and spring wheat separately (but not shown here) shows that the two northern tiers of counties raise more spring wheat than winter wheat, while in the rest of the state, winter wheat predominates over spring wheat in acreage. Iowa, of course, is in the transition zone between the northern spring wheat belt of the Dakotas and the southern winter wheat belt of Kansas. These last three maps of grains—corn, wheat, and barley—show the highest percentages occurring in the west and northwest parts of the state, where highest percentages of land in farms and farmland in crops are found.

The distribution of land used for hay (Map X) shows two major areas of concentration, both of which are in the eastern half of the state. The larger area is in the northeast, where local relief is greatest, where the percentage

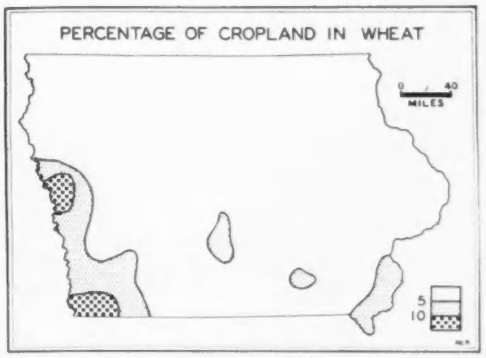

FIGURE 8.—Very little of the cropland of Iowa is planted to wheat. The pattern of distribution compares with that of corn.

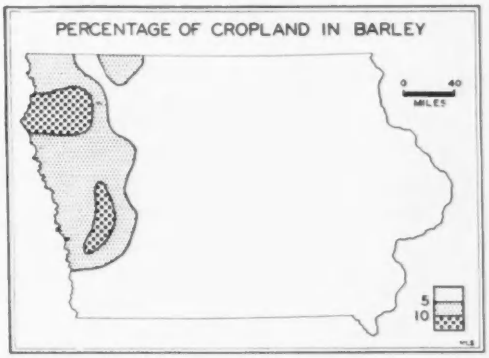

FIGURE 9.—Like wheat production, barley production is concentrated in the western part of the state but is farther north than wheat.

of farmland in woodland is highest, and where percentages are lowest in area in farms and farmland in crops. The other area of concentration is in the two southern counties most publicized for their greatly eroded lands. This latter area also shows the highest percentage of plowable pasture occurring here (Map IV). Areas of lowest concentration occur in the northwest, where most of the land is in grain crops. About 9 per cent of this cropland is in hay.

On Map XI, showing cropland devoted to soybeans, percentages compare with those of wheat and of barley. However, the distribution pattern differs

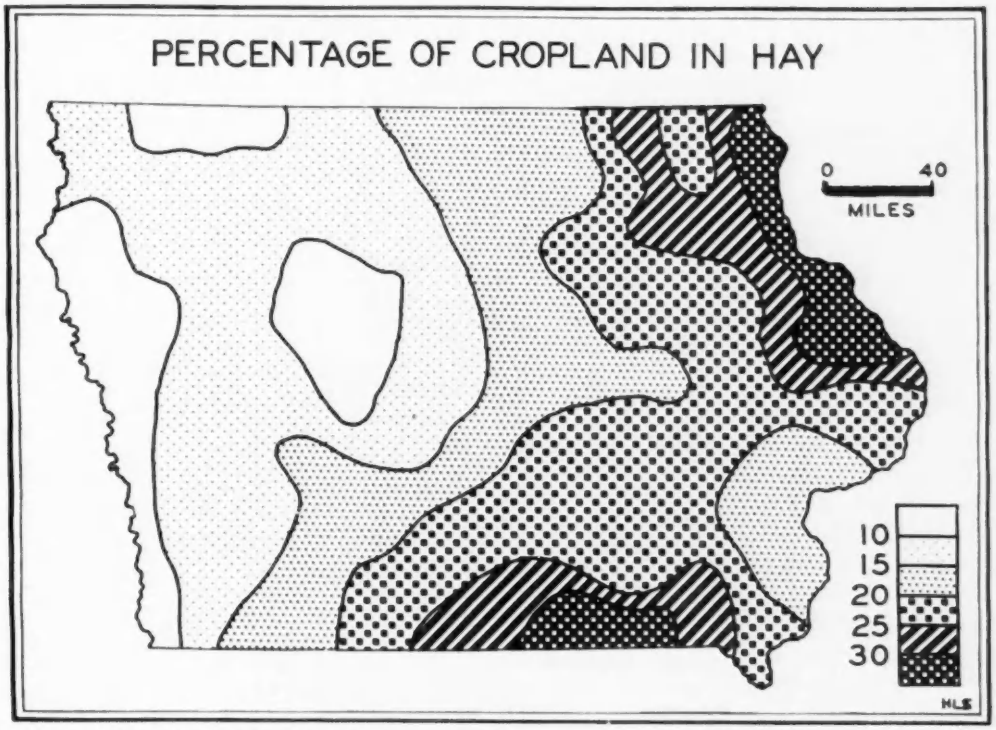

FIGURE 10.—Cropland in hay is concentrated in two major areas. The one in northeastern Iowa is also the area where the percentage of farmland in woodland is highest. The southern area compares with the highest percentage of plowable pasture and the most eroded lands of the state.

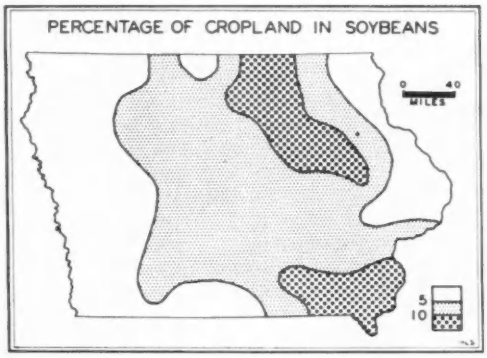

FIGURE 11.—Soybean production is also concentrated in two major areas but differs from all other crop distributions in that these areas are located between those of the grains in the west and hay production in the east.

in that the areas of highest acreage are in the east central part of the state between the areas of greatest hay production in the east and the areas of greatest grain production in the west.

After this brief survey of the distribution of farmland and the major cropland uses, a study of the next two maps showing livestock distribution and milk production gives a basis for determining the types of farming engaged in over the state.

Map XII shows the pattern of livestock distribution by indicating the number of livestock units per 100 acres of cropland. The range is from 20 to 46. This map offers an interesting contrast to the preceding crop distribution maps. Whereas the eastern and northeastern sections of the state have been low in areal extent of grains and percentage of farmland in crops, they here show the greatest intensity of production of livestock units, highest percentages occurring in the middle portion of the eastern border. Maps showing hay production and woodland are quite similar in pattern to this map. The lowest percentages are found in the relatively flat Wisconsin glacial drift area, where the highest percentages

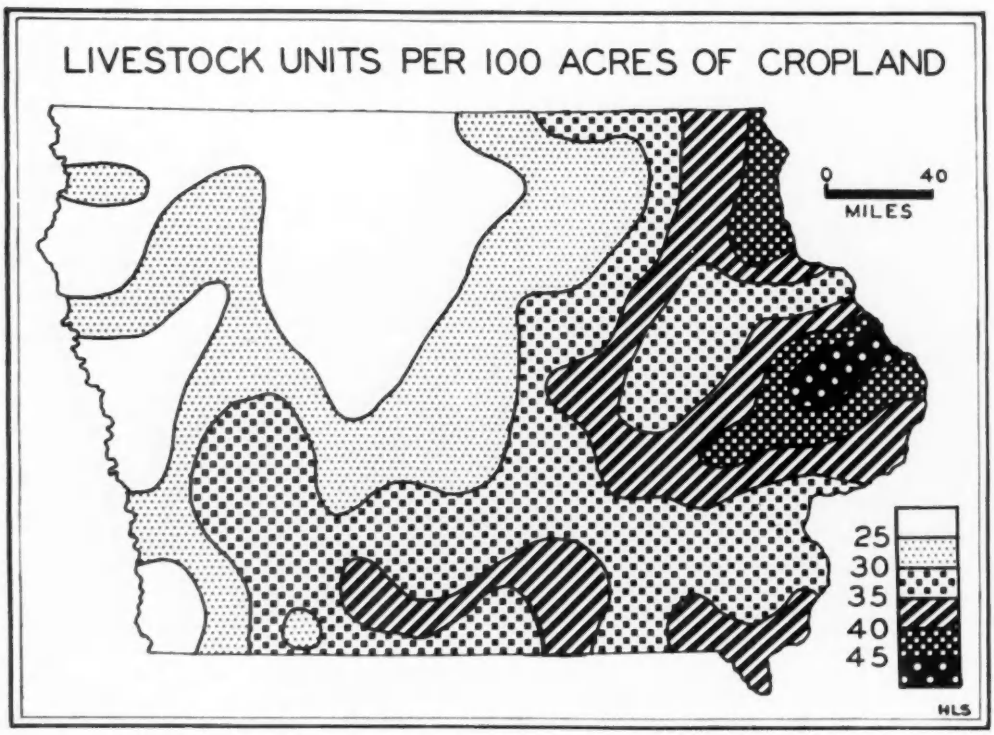

FIGURE 12.—Livestock production is highest where grain production is lowest.

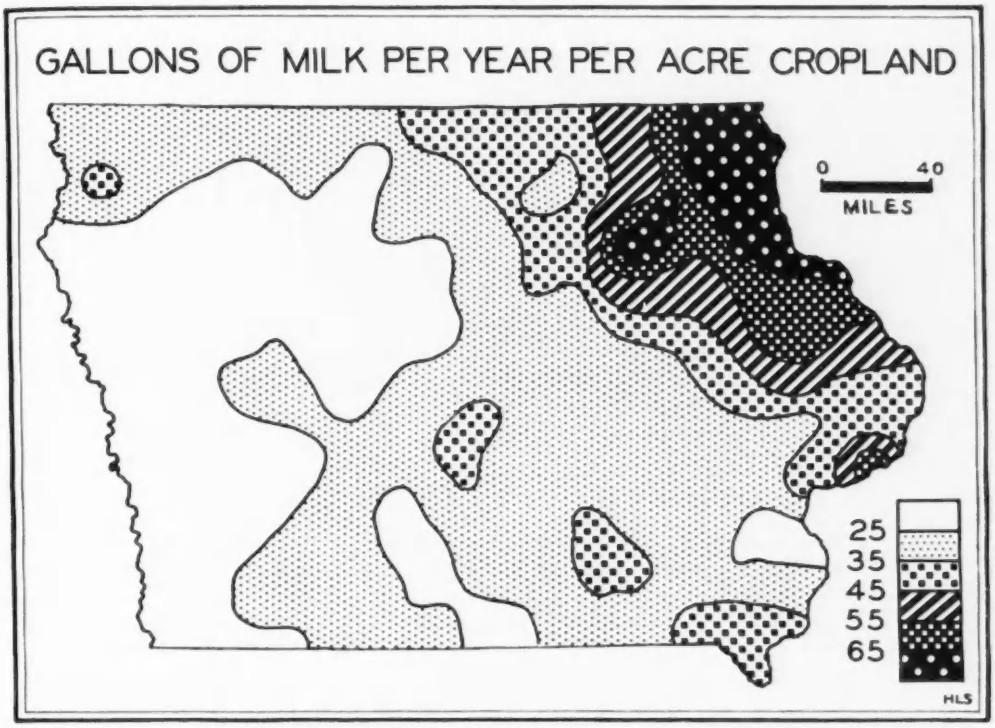

FIGURE 13.—Gallons of milk per year per acre of cropland range from 17 to 79 per cent. Thus, dairying is most important in the northeast, where hay land is also concentrated.

of farmland in crops and highest percentages of cropland in oats occur.

Areal distribution and intensity of dairying can be indicated by various measures. Map XIII shows gallons of milk per year produced per acre of cropland. The Driftless Hill Lands of the northeast are highest in milk production. The same area shows the percentage of farmland in crops to be lowest in the state. A comparison of this map with the hay map (Map X) reveals a correlation between good hay and pasture land and intensity of milk production.

When types of farming in Iowa are determined by applying the data of Maps XII and XIII to the Table of Criteria below, most of Iowa classifies as Commercial Crop and Livestock Farming; the thirteen counties of northeastern Iowa, producing more than fifty gallons of milk per year per acre of cropland, are considered Dairy Regions; most of the western half of the state and one small area in the southeast is Commercial Livestock Farming. (Adapted from Jones, W. D., "Ratios and Isopleth Maps in Regional In-

TABLE OF CRITERIA

	Livestock Ranching	*Commercial Grain Farming*	*Dairy Farming*	*Commercial Livestock Farming*
% total land in all crops	Less than 20	.....	.....	More than 20
Total livestock units per 100 A in all crops	More than 30	Less than 20	More than 20	More than 20
No. of Gallons of milk produced per acre in all crops	Less than 25	Less than 25	More than 50	Less than 25

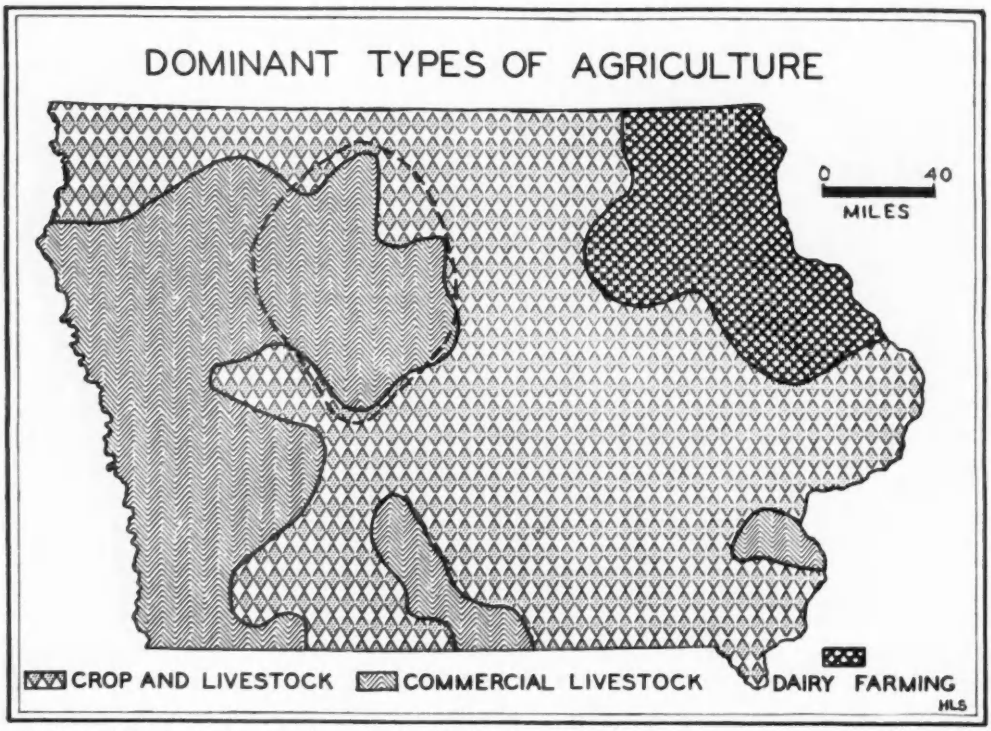

FIGURE 14.—Agriculture in Iowa is classified under three dominant types—commercial crop and livestock, commercial livestock, and dairying—with an area in the northwest (broken line) showing some characteristics of a commercial grain belt.

vestigation of Agricultural Land Occupance," *Ann. Assoc. Am. Geog.*, XX Dec. 1930, p. 182.)

An area comprising nine counties just northwest of Des Moines and indicated by the broken line on Map XIV shows ratios which very nearly classify it as Commercial Grain Farming. Although grains occupy a great percentage of the cropland in this representative Corn Belt state, little grain is sold. Most of it is fed to livestock on the farms. Thus the sale of livestock and milk products comprises the chief source of cash income on farms.

Although Iowa is a representative state of the Corn Belt, it shows interesting variations in utilization of agricultural land. Here under an intensive system of farming, a corn mized-farming economy reigns. Progressive farming and a standard of living higher than that in any other humid middle latitude agricultural area of the world are in evidence. Here on the gently rolling plains one sees a rectangular road pattern made possible by the generally level topography of the land. Here are dispersed rural farmsteads nestled in a sea of crop and pasture lands, with the ever-present market village in the distance, and at greater distances a city with its slaughtering and meat-packing plants and other industrial developments.

A purely statistical basis for investigation of agricultural land use has its limitations, but it has utility as a method of landscape description and is a worthwhile "quantitative phase of human geography." The construction of maps based on published data brings to light more accurate regional knowledge. Will the statistics obtained in the 1950 census reveal much change in intensity of various agricultural phenomena?

AN INDEPENDENT FARM IN CUBA

R. L. Tuthill

THE agriculture of Cuba is dominated largely by sugar growing. Although Cuban agriculture is less a monocultural economy than is commonly supposed, overemphasis upon sugar cane lies at the root of the island's serious "farm problem." This is clearly evidenced by the general pattern of land holding. On the one hand are great sugar *centrals* representing corporate holdings of large American domestic companies or large private *haciendas* of Cuban landlords. On the other hand, are small subsistence patch-gardens of *bohio*-dwellers. On lands of the former, the agriculturist or farm worker is reduced to the status usually of an underpaid laborer; on the latter he is variously a squatter, sharecropper, or part-time laborer eking out a miserable existence.

Somewhere between *hacienda* owners and *bohio*-dwellers, there is a small group of owner-operators of the small independent farms. Distinguishing features of such a farm are: (a) a unit of land large enough to support a family on a relatively decent standard of living, (b) a varied enough production to supply most of the basic needs of the family, (c) a market crop to furnish a basic cash income, and (d) an owner actually in residence on the farm and performing the farm work.

Such small independent farms are relatively few in Cuba, tending either to be prevented or to be crowded out by the foreign corporation and the domestic aristocracy which have first call on almost all the better grades of land. Yet most Cuban students of the matter insist that the only remedy for their farm problem is the sponsorship and development of these small independent farms on a very wide scale throughout the island.

With this in mind the field study was carried out on which this paper is based. Preliminary examination revealed not only that farms of the desired type are now comparatively few, but that their frequency of occurrence varies considerably throughout Cuba as a whole. The three eastern states—Oriente, Camaguey, and Santa Clara—are largely dominated by the big land holdings with sugar, cattle, and tobacco leading. Oriente produces some coffee, whereas in Camaguey and Santa Clara cattle rearing is particularly important. Westward, in the state of Matazanas, sisal is added as a major product of the large haciendas. The number of small independent farms, however, here noticeably increases. Still farther westward in Habana and eastern Pinar del Rio the number of such farms reaches a maximum, although even here the count is not large. In western Pinar del Rio, the landscape is again almost exclusively dominated by the large corporate or privately held tobacco plantations.

The general pattern of commercial agriculture varies rather markedly from one part of the island to another, and, in accordance with this, the crop pattern of the small independent farm also varies. Consequently, it is most difficult to generalize sufficiently to describe the "typical" farm of this class. Never-

theless, if care be exercised to select a fairly representative sample farm, it should reveal the general traits of this specific type of agricultural adjustment and give certain clues as to its usefulness as a solution for the general farm problem of Cuba.

A SAMPLE FARM

The farm finally selected for close study was the *Las Cruces* (nearly all farms in Cuba have names) near Guachinango in Habana, about 39 kilometers (18.4 miles) from the capital city. The owner, Sr. Pio Martinez, aged 45, has owned and operated his farm for 20 years. The farm is perhaps slightly larger than average, being one and a quarter caballeria in area (one caballeria equals 33½ acres).

Lying as it does near the windward coast, *Las Cruces* gets as much rain as any locality in middle Cuba—slightly over 50 inches. The rainfall is tropical monsoonal in its general character, with the rainy season lasting from May through October. However, Cuba has no truly dry season; the rains merely fall off from a maximum of six to 10 inches to about two inches monthly (see climatic charts for Habana City and Camaguey City). Since frosts are lacking, the growing season is year round.

The soil of *Las Cruces*, as is that of most of the small independent farms, is lateritic, and definitely second class in fertility. It is a bright red sandy loam and, although decidedly level, it is quite stony. Had the soil been of the best grade Sr. Martinez could not have afforded to buy it. Moreover, possession of a large piece of high grade land would have tended to make him an absentee gentleman farmer rather than an actual "dirt" farmer. He makes no complaint,

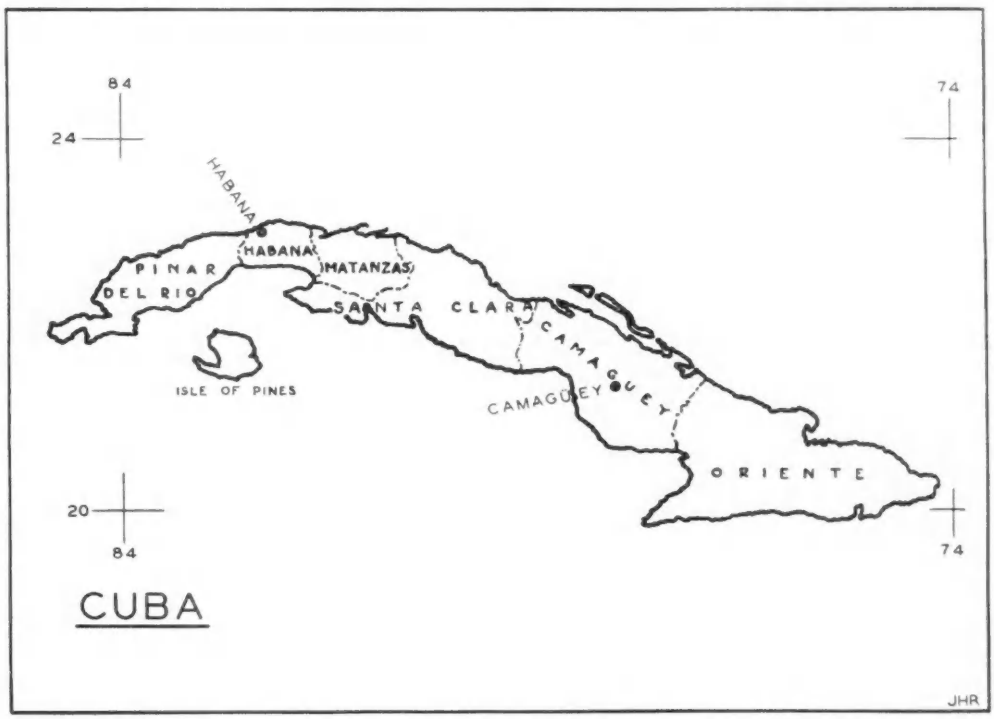

FIGURE 1.—Number of small independent farms increases westward from Matanzas to eastern Pinar del Rio; while the three eastern states of Cuba are largely dominated by the big land holdings.

however, for the soil is reasonably productive and the climate is most favorable. By adding his long and arduous labor to these natural assets, he has achieved an enviable status, well above that of the *bohio*-dwellers with their poor garden patches which can be found not far from his own farm. He supports a wife, three children, a mother-in-law, and a hired hand, and enjoys a standard of living far superior to that of the Cuban agricultural laborer. He seems to achieve the same satisfactions from owning land and successfully tilling it that most United States small farmers possess. Moreover, these things are his to pass on to his son—an important Cuban consideration.

THE FARM EQUIPMENT

Owning and operating a farm such as *Las Cruces* is not an insignificant undertaking. It requires more than a strong back and ambition. For its success, there is required organization and coordination, family cooperation, and some knowledge of price trends and market conditions in addition to agricultural "know-how."

There are three major crops produced on this farm: tobacco, the cash crop (replaced by sugar on many farms to the east); corn, the staple food and feed crop; and bananas, used for food, feed, and cash at the local market. Minor agricultural products include a dozen kinds of vegetables and fifteen varieties of tree crops. Livestock consists of cattle, horses, oxen, pigs, poultry, and bees. The farm implements comprise four plows (two of which are of United States manufacture), one homemade harrow, and an ox cart.

For buildings, the farm has a farmhouse, a tobacco barn, a corn crib, and an implement shed with sleeping quarters for the hired help. Because of the mildness of the climate, no stables for livestock are required.

The farm requires the full-time labor of its owner, and his son helps during the hours when he is not at the village school. The women of the family tend the bees and poultry, and spend considerable time helping with the minor crops. The women are also pressed into service for the processing of the tobacco crop.

The combined efforts of the family are, however, inadequate to operate the farm. Consequently, Sr. Martinez employs a full-time farmhand and during certain periods an additional farm laborer. The farmhand is a strong, hard-working young man who has been employed on the farm since boyhood. His work is done not for wages but for a share of the total produce. This share has been gradually increased until at present it has reached the maximum figure of 25 per cent. This is a high percentage, but the owner feels that it has been justified by creating loyalty and increased production. In addition, there is the possibility of marriage of his elder daughter and the eventual creation of a new independent farm family. The part-time farm labor is paid wages, and during certain phases of the processing of tobacco as many as ten extra women laborers are hired. These latter work for cash wages by the day.

THE MAJOR CROPS

Corn. Among the major crops, corn may be regarded as the principal subsistence crop. It is the basic food for the family and the basic feed for the livestock. The amount of land given over to corn growing varies from year to year, but it is probable that on the average, considerably more than half of the cultivated land of the farm is devoted to it. Corn can be, and is,

grown the year round. Small plantings are made in rotation so that green corn is available at all times. The largest planting is made in late November after the young tobacco plants have been set out. Another sizable planting occurs late in January while the tobacco leaves are curing.

No fertilizer is used on corn land nor does there seem to be any planned rotation of corn with other crops. Cultivation is not intensive; in fact, it seems quite haphazard. The young plants are hilled two or three times and weeds are kept down, until the corn is about knee high. After that the field is untended until picking time.

A great number of Cuban food dishes have corn as one of the chief ingredients. *Tamales* are prepared from powdered corn and pork; *harina de maiz con dulce* closely resembles our own corn meal mush; *majarete* is a preparation of corn flour, water (or milk), sugar, and flavoring squeezed through a cloth, heated, and served hot. Corn is often mixed with rice to give it a different flavor.

Similarly, corn is the basic livestock feed. After the corn is picked, the animals are turned out into the fields to eat fallen ears, nubbins, and stalks. Some corn is cut green and cured for fodder to supplement the small scraps of natural pasturage to be found in odd corners of the farm. *Las Cruces* at the time of this study boasts of two horses, eight cows, one bull, four oxen, three sows, and one boar. Seven or eight calves and about 24 pigs are produced yearly. The calves are sold for veal, but the young pigs are fattened on corn and eaten by the family during the year. Poultry, consisting of 150 laying hens, 50 pullets, five cocks, eight guinea fowl, and six ducks, are given two slender feedings of corn daily. For the bulk of their diet, however, they must forage for themselves but there are many insects, greens, and seeds to supplement their feed. From the hens come only 250 eggs per week. Eggs not consumed by the family are bartered at the general store in Guachinango. The other poultry is eaten at a rate that permits its regular replacement.

Bananas. Almost every independent farm possesses at least one plot of bananas. It occupies a relatively small area but has considerable utility both as a food and forage crop. As with corn, the banana is part of no planned rotation and receives no special fertilizers, no irrigation, and precious little cultivation. A typical planting consists of setting out some 400 to 500 shoots spaced about 15 feet apart although there is variation in distance dependent upon variety. For the first 90 days the weeds are chopped down after which the plants are left to themselves. Other plantings are made throughout the year so that periods between harvests are relatively short. When the yield of individual plots is finished the stalks are cut down and the livestock turned into forage. Remnants are plowed back into the soil which helps to maintain a high humus content.

Most farms grow several varieties of bananas. Sr. Martinez raises small amounts of Johnson bananas (a yellow type well known in the United States), but he does not regard them highly for they require too much care both in cultivation and handling. In addition, he grows four other types: *enanos*, *manzanos*, *platano macho*, and *ciento en boca*. These, depending upon the type of fruit or the preferences of the palate, are eaten raw or fried, baked, boiled, or broiled. A few bunches are bartered at the local market but profits are very small indeed.

Tobacco. Tobacco is the cash crop of *Las Cruces*. The owner might grow

sugar cane instead and sell it to an independent *central*, but there are two reasons why he elects not to do so. First, competition in cane is more severe than in tobacco. Second, this farm is near to Habana which is the great primary tobacco market.

The amount of land given over to tobacco is not excessively large, but considerable care and a very sizable amount of time, energy, and money are expended upon its production. Almost every *bohio*-dweller has a patch of corn and bananas but he does not have tobacco. It is the cash income from this last named crop (or another crop) that differentiates the independent farmer from the unenviable patch grower.

The tobacco field is a plot some 200 meters square (roughly 650 x 650 feet), located on the best soil of the farm. Sr. Martinez has four such fields which are worked on an eight-year rotation. Each plot is cropped for two years, after which it lies fallow for six. After six fallow years, the soil is fertilized with commercial nitrates, phosphates, animal manure, and compost. It is plowed two or three times to mix the fertilizers, and then harrowed. Next, some 1,700 feet of pipe are laid for irrigation. Then the plot is staked and covered with cheesecloth.

The young plants are nursery-bed raised, starting about September 25, and by the first of November the seedlings are ready for transplanting. They are planted at this time, which is the beginning of the dry season, in order to control the amount of water received by the plant, which is done through irrigation, and thus to regulate growth of the premium leaves. The irrigation pipes are connected to a large water tank, kept filled from a 40-foot well. The water is drawn from the well by ox-power, but is distributed over the field by gravity flow. The tobacco plants are watered in mornings and in evenings.

The plants are not allowed to become fully mature. The practice is to cut just before the leaf reaches maximum size while it is still relatively tender and mild. Cutting normally begins shortly after New Year's Day, and is all carefully done by hand, leaf by leaf. This necessitates going over the field several times removing the leaves as they reach the desired size.

Curing is done in the tobacco barn. This is the largest structure on the farm, measuring some 22 x 12 x 12 meters (roughly 72 x 40 x 40 feet). It is made of pine or palm wood, thatched with palm leaves. The interior of the barn, except for a small space in the center, is filled with a framework of crossed poles. This forms a rack for supporting the poles of *baria* wood (called *varas*) upon which the tobacco leaves are hung. In the center of the barn there is a pit about 3 x 3 x 3 meters (roughly 10 x 10 x 10 feet) in size built to hold a wood fire. The leaves of cut tobacco are tacked together in pairs and hung over the *varas*. When the barn has been heated to 80° C. (176° F.) the *varas* are racked, the barn closed, and the leaves are left to cure for 48 hours. Then the fire is removed and the leaves left for another 24 hours. Finally, the barn is opened and the leaves are left for 40 days.

At the end of this time, preparation for market begins. The ten women employed by Sr. Martinez are set at the task of sewing the leaves. The cured pairs of leaves are sewed in bunches or packages of 400 each, each bunch being known as a *matul*. The *matules* are stacked in piles in the barn and left for 20 days, then they are shuffled and restacked and left for 20 more days. Thus the entire process from cutting

to completed curing involves three months of episodic concentrations of labor.

The tobacco now being ready for sale, Cuban or American buyers from Habana visit the farms to examine and bid on the crop. Four criteria are used in determining its value: lightness of color, length of leaf, smell, and taste or flavor of the tobacco. Prices, of course, vary not only from farm to farm but also from year to year depending upon the world market price, since leaf tobacco is an international commodity. Prices during the past 20 years have ranged from 80 cents to three dollars per *matul*. Sr. Martinez produces an average crop of about 1400 *matules* of high grade leaves. After the costs of production, including labor, have been deducted and a portion of the net profit given to his farm laborer, the cash profit amounts to somewhere between 600 and 2000 dollars depending on the market price. This cash income is the basis of the farmer's independence. His social standing is determined by the degree of success or failure of his tobacco crop over a period of years.

THE MINOR CROPS

Vegetables. *Las Cruces* produces many varieties of vegetables. Although they are produced primarily for family use, local markets at Guachinango and Habana are too close to ignore (see chart). Because Sr. Martinez is energetic and enterprising, he has found a place in the Habana market. Therefore, his farm produces a much larger quantity than most of the farms of its type. All of the vegetables except the pumpkin necessitate some cultivation, but they are easily grown and of good quality. For the most part they are cared for by the women and children. Those picked for market are boxed by the men and conveyed by truck to Habana. *Yuca* is the principal vegetable and is widely used locally. *Aji*, *berenjena*, and tomatoes which are now being sent to the United States represent a new venture of questionable value on this type of farm. However, the Habana wholesaler carries the major risk of profit or loss, not the farmer.

Tree Crops. Sr. Martinez cultivates many kinds of crop-bearing trees (see chart). By far the most highly prized fruit tree is the *Mamey*. This tree, which begins to bear at 20 years and continues to yield for 100 years, has the desirable habit of bearing fruit the year round. Always there are blossoms, green fruit, and ripe fruit concurrently on each individual tree. The fruit is used fresh or its juice used in ices or as a cold drink. No fruits are sent to the United States.

Of the other trees, the *palma criolla* or Cuban palm and *baria* are important. They grow anywhere, require no care, and have a multiplicity of uses. The *cedro* is the prize building wood, but it is relatively scarce. The *almacigo* is the most plentiful and is commonly used for fences being considered preferable to stone for this purpose. Each fence is marked off by planted rows of *almacigos* 20 to 25 feet apart. The mature tree ranges from 12 to 18 feet high, is about six inches in diameter, and has few branches or leaves. Wire is stretched from tree to tree making an effective fence that need not be touched for many years. The *ceiba* is the most highly regarded tree in Cuba. It is an excellent shade tree and also produces a fluffy, fibrous boll of lint that is used for stuffing pillows and mattresses. The *ceiba* has become a natural symbol of the country and consequently is much prized for sentimental reasons. It is by far the largest of the trees mentioned.

CHART OF MINOR CROPS

Crop	*Amount*	*Market*
Yuca	5 tons	home and local market
Boniato (sweet potato)	1 ton	home and local market
Malanga	1 ton	home and local market
Aji	(a) 200 50-lb. boxes	United States
Berenjena (squash)	(a) 100 50-lb. boxes	United States
Tomatoes	(a) 100 50-lb. boxes	United States
Beans	(b) 1.5–2.5 tons	home and local market
White potatoes	(c)	home and local market
Cabbages	12,000 plants	home and local market
Onions	2,000 plants	home and local market
Garlic	1,000 plants	home and local market
Pumpkins	(d)	home and local market

(a) The amount indicated is the amount shipped to the United States only. The home and local market are also supplied.
(b) The amount of beans varies considerably and is dependent upon the weather. A scarcity of rain diminishes the crop.
(c) The amount here is considerable. About 20 barrels are used as seed and both the home and the local market are supplied. However, the farm peoples much prefer boniatos.
(d) Pumpkins are grown with the corn and no accurate account is kept of the actual number. Several thousands was the figure given.

CHART OF TREE CROPS

Fruit Trees	*Number*	*Use*
Avocado	25	home and local market
Naranja de China (sweet orange)	20	home and local market
Naranja Agria (sour orange)	20	home and local market
Guajaba	20	home and local market
Anon	10	home consumption
Mamey	5	home consumption
Mango	3	home consumption
Guanabana	3	home consumption
Limon	3	home consumption
Totals: 9 varieties	109	
OTHER TREES		
Almacigo	several hundred	live fence posts
Baria	300	building, fuel, miscellaneous
Palma Criolla (Cuban palm)	40	roof thatch, nuts for swine
Cedro (cedar)	10	building
Ceiba	3	pillow and mattress stuffing

THE FARMHOUSE

The farmhouse of the independent farmer is the chief evidence of his social status. It compares very unfavorably with the homes of the central officials of Cuban landlords or of the officials on the big centrals, but it is definitely superior to the ordinary laborer's *bohio*. Since the alternative to agricultural independence in Cuba is economic servitude and not wealth, it is natural that the independent farmer should express his personality in the construction and equipment of his home.

The house is adequate but not very roomy. In plan it contains a central living room with a bedroom on either side, a dining room, and a kitchen with a storage shed attached. There is no cellar, no bathroom, no attic, and no closet space. But unlike the *bohio* it does have partitions between the rooms although no ceilings to these rooms. It has porches on the front and the back,

FIGURE 2.—The farm house of Las Cruces. Note the corrugated iron ridge-cap and porch roof.

and sports a corrugated iron porch roof and ridge cap. These details are indications of cash income and independence.

The roof is made of thatched palm leaves several inches in thickness, laid and tied to *baria* rafters. The ridge cap of sheet iron prevents leakage of rain and destruction of the palm ends by wind. The front porch roof of corrugated iron makes the porch a veritable oven at midday, but it advertises to the passer-by the status of the farmer, and is therefore considered essential.

The side walls are of pine or cedar and are painted white both inside and out. There are no window or door frames, but the openings in the walls are outlined inside and out with a band of red or blue paint. Formerly, the color indicated the political affiliations of the inhabitant. Neither the windows nor doors are screened. The multitude of insects which constantly plague the visitor go unrecognized by the members of the Martinez family. There are blinds for the windows and doors, as protection against rain and wind. The red floors of the rooms are of concrete except for that of the kitchen which, like the floors of the poorest *bohios*, is earthen.

The furniture and utensils are indicative of independent farm status, since they are for the most part bought rather

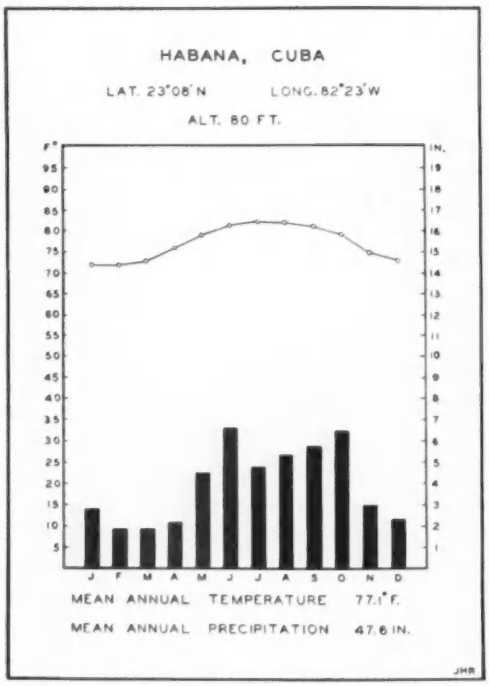

FIGURE 3.—The rainfall of Cuba is tropical monsoonal in general character, with rainy season lasting from May through October.

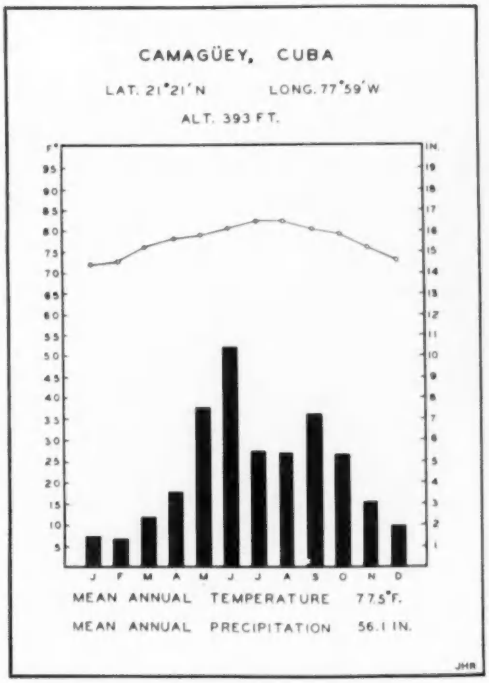

FIGURE 4.—Cuba has no truly dry season. Precipitation runs from a maxima of six to ten inches to two inches monthly.

than homemade. The stove, although built on the premises, is made of purchased materials being constructed of fire bricks and sheet iron. The oven is heated by an open fire which is kept constantly burning atop the stove. It is really only a trench of firebrick covered by sheet metal. The smoke drifts out through windows and doorway. The pots and pans, the dishes, most of the furniture and textiles have been accumulated gradually by purchase. The fact that the house affords a sufficient number of dishes (differing astonishingly in size, shape, and design) to feed all of the family and guests at the same time, is an important indication of status.

Actually all of the materials for constructing and repairing farm buildings, with the exception of cement, metals, firebrick, and paint, come from the farm itself. Like the American farmer, Sr. Martinez and his two helpers are

FIGURE 5.—The tobacco barn of Las Cruces. Amount of land given over to tobacco is not large, but much time, energy, and money are expended upon its production.

efficient builders and repairmen who take considerable pride in their practical accomplishments.

CONCLUSIONS

All in all, this type of farm is a favorable adjustment to the natural environment of Cuba. Certainly, farm life of this sort calls for many hours of hard work each day, but the land is fairly fruitful and the rewards are substantial. That there is much room for improvement is obvious. One can hope for increased attention to sanitation, to plumbing, to electrification, and to increased agricultural education. But by sweat and toil energetic tropical farmers such as Sr. Martinez have lifted themselves far beyond the level of the *bohio*. The degree of independence is considerable by comparison, even though the world market determines the actual yearly cash income. As with his American counterpart, the Cuban farmer need never worry about food and shelter; what is more, the clothing problem is far simpler in the tropics. The two products, tobacco and sugar, are commodities basic to the world in which we live. There may therefore be considerable variation in world market price, but there is little danger that the market will cease to exist. The great variety of products which can and are being grown is certainly indicative of the absurdity of branding Cuba as an essentially monocultural area. The potentialities are great, and the Cubans want only the chance to own small parcels of land and to raise a diversity of crops. The standard of living enjoyed by the independent farmer is in many ways inferior to that which

FIGURE 6.—The kitchen attached to the rear of the farmhouse.

Americans are likely to consider essential to economic independence. But it is so superior to that of the average hired agricultural worker of Cuba that it furnishes a most worth-while goal toward which such unfortunates may validly strive. The economic uplifting of the *bohio*-dweller is contingent upon many factors not the least of which is his present inability to successfully develop and maintain his economic independence. Generations of servitude and its concomitant circumstances have taken their toll upon his initiative and efficiency, but the existence of the independent farm here and there acts as a spur to, as well as a goal for, these people. It may be said with certainty that independent farming is conducive to a happy family life, more happy in many respects and affording much greater security than that enjoyed by the urban family at a comparable economic level in Cuba.

MOUNTAIN PASSES IN THE COLORADO ROCKIES

Earl E. Lackey

THE Front Range of the Colorado Rockies is an impressive rampart indeed as seen from the Great Plains. But the Front Range is no more formidable as a barrier than are several other ranges, for example, the Park Range, the Sangre de Cristo, the Sawatch, and the San Juan ranges (Figure 1).

Main east-west highways crossing the Colorado Rockies, shown by heavy black lines on the map, lead through numerous passes over which millions of people travel every year (Figures 1 and 2). Among the best known are Fall River (9) and Milner (8) on U. S. Highway No. 34; Berthoud (15) and Rabbit Ears (5) on U. S. No. 40; Love-

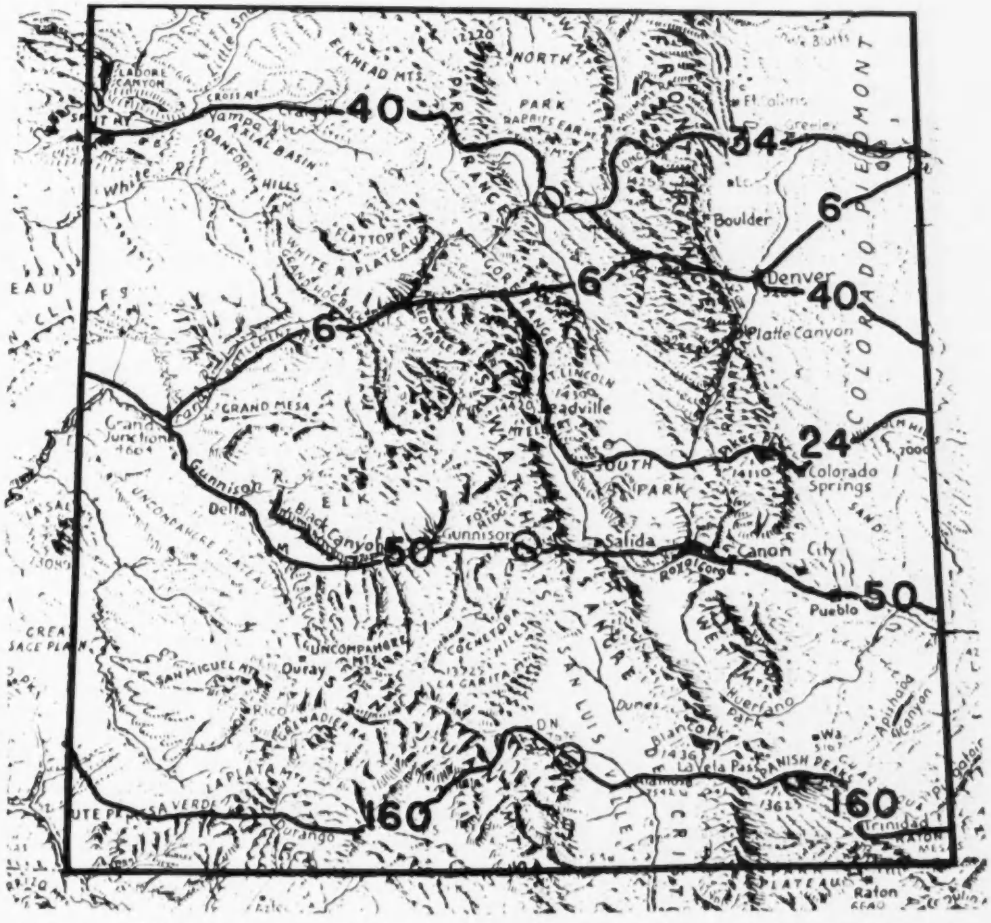

FIGURE 1.—The major east-west highways across the rugged Colorado Rockies are shown in this diagrammatic sketch. Some of the significance of the traffic over these highways is indicated in the following maps and graphs. (Sketch is a part of "Land Forms of the United States," by Erwin Raisz, Institute of Geographical Exploration, Cambridge, Mass., 1939.)

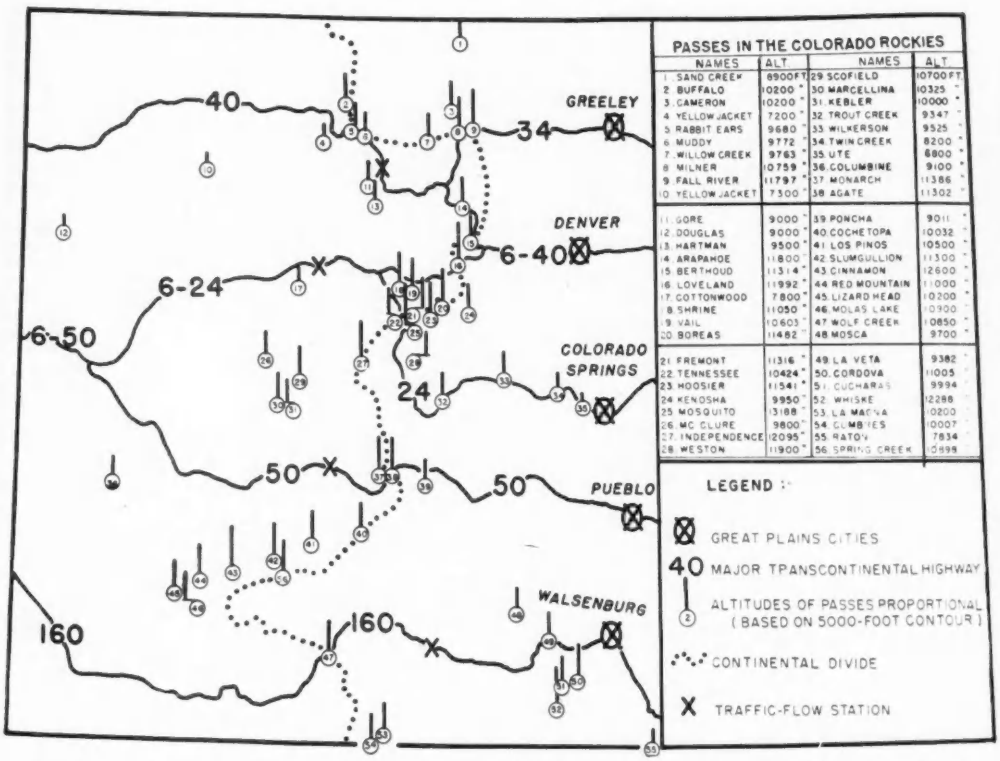
GREELEY
DENVER
COLORADO SPRINGS
PUEBLO
WALSENBURG
40
34
6-40
6-24
6-50
24
50
160
PASSES IN THE COLORADO ROCKIES
NAMES ALT NAMES ALT
1. SAND CREEK 6900FT 29. SCOFIELD 10700FT
2. BUFFALO 10200 " 30. MARCELLINA 10325 "
3. CAMERON 10200 " 31. KEBLER 10000 "
4. YELLOW JACKET 7200 " 32. TROUT CREEK 9347 "
5. RABBIT EARS 9680 " 33. WILKERSON 9525 "
6. MUDDY 9772 " 34. TWIN CREEK 8200 "
7. WILLOW CREEK 9763 " 35. UTE 6800 "
8. MILNER 10759 " 36. COLUMBINE 9100 "
9. FALL RIVER 11797 " 37. MONARCH 11386 "
10. YELLOW JACKET 7300 " 38. AGATE 11302 "
11. GORE 9000 " 39. PONCHA 9011 "
12. DOUGLAS 9000 " 40. COCHETOPA 10032 "
13. HARTMAN 9500 " 41. LOS PINOS 10500 "
14. ARAPAHOE 11800 " 42. SLUMGULLION 11300 "
15. BERTHOUD 11314 " 43. CINNAMON 12600 "
16. LOVELAND 11992 " 44. RED MOUNTAIN 11000 "
17. COTTONWOOD 7800 " 45. LIZARD HEAD 10200 "
18. SHRINE 11050 " 46. MOLAS LAKE 10900 "
19. VAIL 10603 " 47. WOLF CREEK 10850 "
20. BOREAS 11482 " 48. MOSCA 9700 "
21. FREMONT 11316 " 49. LA VETA 9382 "
22. TENNESSEE 10424 " 50. CORDOVA 11005 "
23. HOOSIER 11541 " 51. CUCHARAS 9994 "
24. KENOSHA 9950 " 52. WHISKE 12288 "
25. MOSQUITO 13188 " 53. LA MACHA 10200 "
26. MC CLURE 9800 " 54. GUMBYIES 10007 "
27. INDEPENDENCE 12095 " 55. RATON 7834 "
28. WESTON 11900 " 56. SPRING CREEK 10499 "
LEGEND :-
GREAT PLAINS CITIES
40 MAJOR TRANSCONTINENTAL HIGHWAY
ALTITUDES OF PASSES PROPORTIONAL (BASED ON 5000-FOOT CONTOUR)
CONTINENTAL DIVIDE
X TRAFFIC-FLOW STATION

FIGURE 2.—This map involves the same area and highways that are shown in Figure 1. The two should be studied together. However, most of the passes shown are on state or county roads. (Data mostly from "Road Atlas," Commercial Atlas Service, Rand McNally & Co., Chicago, 1946.)

land (16) and Vail (19) on U. S. No. 6; Twin Creek (34) and Tennessee (22) on U. S. No. 24; Agate (38) on U. S. No. 50; and La Veta (49) and Wolf Creek (47) on U. S. 160.

Along the highways and the scores of other highways, roads and trails, scenery of surpassing beauty and grandeur surprises and captivates the eye at nearly every turn. The thrill of driving on U. S. No. 34 from Grand Lake up the Colorado River on a clear summer's day, zigzagging up the steep west face of the Front Range, seeing the Never Summer Range of the Medicine Bow Mountains just across the valley, continuing over the Trail Ridge Road, rolling over the Tundra Curves at an altitude of more than 12,000 feet, and finally winding down the tortuous highway on the east slope to Estes Park village—this in truth is a never-to-be-forgotten experience, that continuously calls for repetition. But the experience is of quite another kind when taken in a fog and snow blizzard as so many persons who have made such trips in bad weather, can attest, particularly in the winter of 1948–49.

The over-all view of the Colorado Rockies (Figure 1) lends emphasis to the impression of rugged relief, but it does not much help visualize the large number of passes that lie within the state. At stations on several of the highways near some of the high Rocky Mountain passes traffic counts have been made. Locations of more than fifty passes are shown by small circles on Figure 2. Numbers within the circles appear also on the upper right margin of the diagram, together with names and

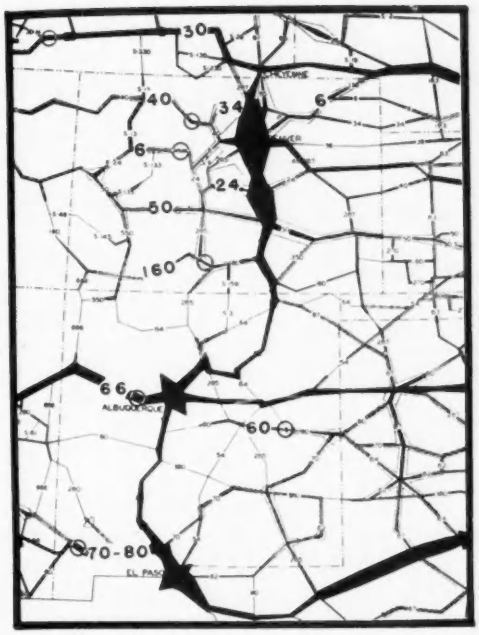

FIGURE 3.—The traffic flow through the Southern Rockies is shown on this map. The relative number of vehicles on each highway is proportional to the width of the lines (1940). The small circles on the highways are approximately the locations of the traffic count stations shown in Figure 4. (Adapted from "Interregional Highways" 78th Congress, 2nd Session, House Document No. 379, 1944.)

altitudes of the passes. Altitudes vary from the low Ute Pass (35) (6800 feet) just west of Colorado Springs to the lofty Mosquito Pass (25) (13,188 feet) northeast of Leadville. Elevations of passes above the Great Plains (5000 feet) as indicated on the map are shown by relative lengths of the vertical bars on the circles. For example, the bar showing altitude of the Ute Pass (6800 feet) in the Rampart Range is short as compared with the bar for Whiskey Pass (12,288 feet) over the Sangre de Cristo Range. It should be noted that most passes associated with the Continental Divide (shown by the dotted line) are relatively high, but it is true that many of the high passes are not on the Continental Divide. Also, some passes that formerly were used extensively (e.g. Mosquito Pass) have been abandoned for longer routes not so difficult to traverse. The X's on the map show locations of some of the stations where traffic counts have been made. Significance of the counts will be explained later.

Initial interests of the writer in passes of the Colorado Rockies were associated with the area as a vacation land, an association in which his enthusiasm is almost unbounded; and he wondered how the high passes in the state affected flow of transcontinental highway traffic. On Figure 3, adapted from a government publication, he has shown the chief trans-Rocky Mountain highways from U. S. No. 30 in southern Wyoming to U. S. No. 70–80 in southern New Mexico, inclusive. Total traffic flow is indicated by width of the lines. As one might expect low routes through Wyoming and New Mexico are as a rule favored over the higher routes in Colorado. However, U. S. No. 160 in southern Colorado is traversed intensively. The really spectacular feature of the map, however, is the intensive north-south traffic on the plains just east of the Front Range together with passenger car movement into the eastern part of the mountains in the vicinity of Denver, of Colorado Springs, and of Loveland.

On Figure 3 several traffic count stations are shown by small circles—stations that are displayed on Figure 4. From north to south these stations are Green River, Wyoming on U. S. No. 30; near Kremling, Colorado on U. S. No. 40; east of Glenwood Springs, Colorado on U. S. No. 6; east of Gunnison, Colorado on U. S. No. 160; east of Ft. Sumner, New Mexico on U. S. No. 60; east of Grants, New Mexico on U. S. No. 66; and west of Deming, New Mexico on U. S. No. 70–80. It should be explained here that counts at selected stations only approximate actual flow

of through traffic, because there is certain to be some local travel on each of the highways. However, special effort was made to select traffic count stations that were adjacent to important passes, and not near large centers of population.

Some effects of the mountain passes as related to winter driving hazards are shown graphically on Figure 4. All transcontinental highways except U. S. No. 70–80 carry most traffic in the summer months. Relative evenness or monthly distribution of flow may be estimated by inspection, but by use of Wright's formula, percentage of evenness may be computed; results are shown numerically in the second column from the right. It is evident that U. S. Nos. 70–80, 66, and 30 carry most traffic; and that steadiest flow is on U. S. No. 70–80 with an evenness of 92 per cent. U. S. No. 30, on which there are almost as many vehicles in winter as U. S. No. 160, has a tremendous increase in summer months, which of course reduces the evenness to 79 per cent. Of highways shown on the graph, U. S. No. 40 with an evenness of only 66 per cent, shows greatest difference in traffic flow between summer and winter.

Gradients on highways over the main passes are not steep—for the most part less than 7 per cent. Figure 5 shows approaches to some of the passes, each inclined line to the left of the small circles being drawn both to linear and gradient scales. It should be noted that the gradient is scaled to 5.28 times the actual, that is, 5.28 feet vertical

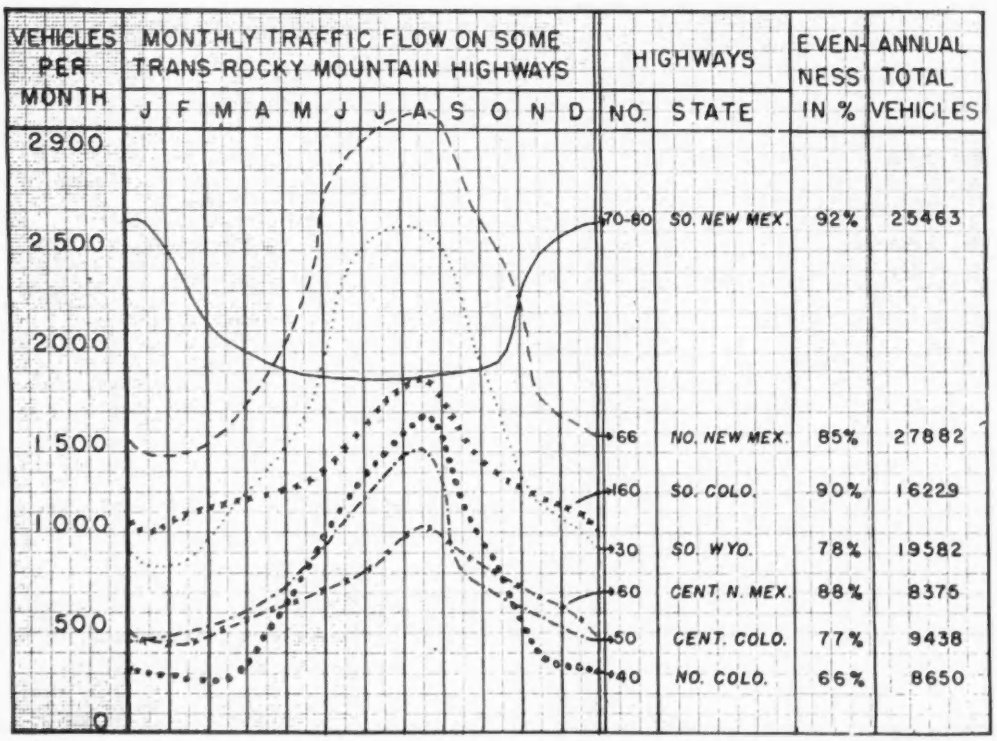

FIGURE 4.—All of the seven highways shown, except U. S. No. 70–80, have peak traffic in the summer months. Evenness of flow as shown in the second column from the right would be 100 per cent if the flow in each of the twelve months were the same. (See "Some Measures of Distribution" by John K. Wright, *Annals of the Association of American Geographers*, December, 1937.) (Data from the State Highway Departments of Colorado, Wyoming and New Mexico at Denver, Colo., Cheyenne, Wyo., and Santa Fe, New Mexico, respectively.)

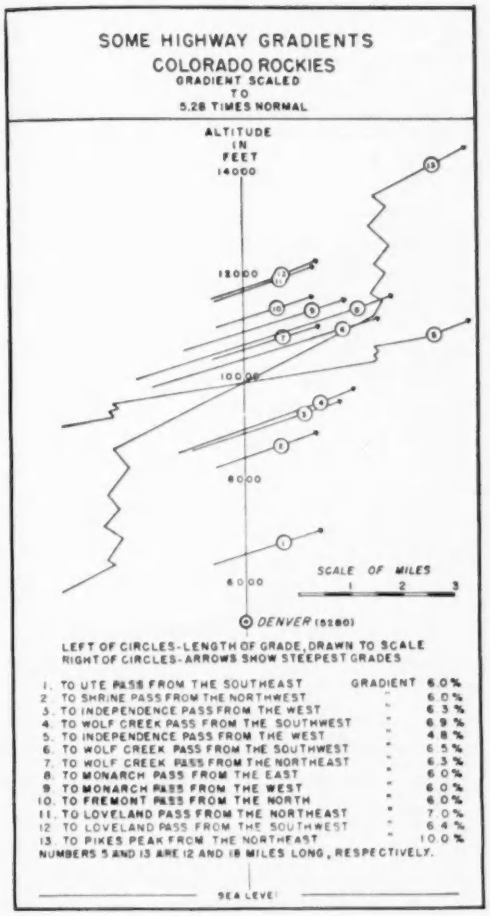
SOME HIGHWAY GRADIENTS
COLORADO ROCKIES
GRADIENT SCALED TO 5.28 TIMES NORMAL
ALTITUDE IN FEET
14000
12000
10000
8000
6000
SCALE OF MILES
1 2 3
DENVER (5280)
LEFT OF CIRCLES-LENGTH OF GRADE, DRAWN TO SCALE
RIGHT OF CIRCLES-ARROWS SHOW STEEPEST GRADES
1. TO UTE PASS FROM THE SOUTHEAST GRADIENT 6.0%
2. TO SHRINE PASS FROM THE NORTHWEST " 6.0%
3. TO INDEPENDENCE PASS FROM THE WEST " 6.3%
4. TO WOLF CREEK PASS FROM THE SOUTHWEST " 6.9%
5. TO INDEPENDENCE PASS FROM THE WEST " 4.8%
6. TO WOLF CREEK PASS FROM THE SOUTHWEST " 6.5%
7. TO WOLF CREEK PASS FROM THE NORTHEAST " 6.3%
8. TO MONARCH PASS FROM THE EAST " 6.0%
9. TO MONARCH PASS FROM THE WEST " 6.0%
10. TO FREMONT PASS FROM THE NORTH " 6.0%
11. TO LOVELAND PASS FROM THE NORTHEAST " 7.0%
12. TO LOVELAND PASS FROM THE SOUTHWEST " 6.4%
13. TO PIKES PEAK FROM THE NORTHEAST " 10.0%
NUMBERS 5 AND 13 ARE 12 AND 18 MILES LONG, RESPECTIVELY.
SEA LEVEL

FIGURE 5.—Note that each of the numbered lines, except 13, represents the approach to a pass in the Colorado Rockies. Each approach is drawn to a horizontal and a gradient scale, the inclination of the latter being 5.28 feet to 100 feet, rather than the usual one to one hundred. Note that sea level is indicated at the bottom of the drawing. (Data furnished by the State Highways Department, Denver, Colorado.)

rise to 100 feet on the horizontal, to make the graph more impressive. The reader should note also length and steepness of the road to Pike's Peak as compared with relatively short approaches and lower gradient to the passes. The scale of inches should be applied only to approaches to the passes, that is, to that portion of the lines at the left of the small circles. For example, grades reach their highest altitudes where inclined lines touch the left margins of the circles. Inclination of the shafts of the arrows at the right of the small circles are designed to show steepest inclination and are not part of the distance to the respective approaches. The graph shows that most passes are at least as many feet above Denver as Denver is above sea level.

It should be noted that most high passes in the Colorado Rockies are closed during winter months, and those in use during the winter require constant vigilance to keep them passable. For example, the high Berthoud Pass on U. S. No. 40 is not closed in winter except when bad storms occur, in which case traffic may be tied up for a day or two, or possibly a week. But even so, through travel on the highway drops to less than 300 cars per month during February and March, whereas the August count is nearly 1700. At the same time traffic on U. S. No. 160 in the southern part of the state carries more than 1100 cars in both February and March, but only a few more in August than the summer-popular U. S. No. 40.

It seems appropriate in conclusion to take another look at the physiographic diagram of the Colorado Rockies—an overview of one of the fine playgrounds of our country, almost a paradise for the naturalist, the artist, and the geographer, and an area in which thirty-four passes are 10,000 feet or more in altitude —eighteen, 11,000 or more feet; four, 12,000 or more feet; and one of which the altitude is more than 13,000 feet.

SAUDI ARABIA'S PETROLEUM RESOURCES

George P. Stevens, Jr.

WORLD crude petroleum reserves are at best an elusive item of oil study statistics, based upon varying degrees of optimism, and under constant and rapid revision. Nevertheless, the more authoritative sources now place the proved reserves of the Middle East at approximately 40 per cent of the world's total. This large portional share of the precious black liquid lying in a retarded region astride the historic Eurasian trade routes, its youthfulness of development, and the ever-increasing post-war demand for petroleum products focus attention Middle Eastward.

Far from the least of this public and official attention has been Saudi Arabia's, and rightly so, for no other area in the Middle East has made such phenomenal advances in exploratory and drilling activity, or in the production of crude and refined oil in the past few years. Tables I, II, and III show the Middle East and Saudi Arabia's comparative position in oil reserves and production.

History

Bahrein. In the early 1930's Standard Oil Company of California bought an option to petroleum development possibilities on Bahrein Island in the Persian Gulf. Geologists had been wary of Arabia because the structure that had made Iran so rich in oil seemed to have been eroded away on the west side of the Gulf. A hunch that deeper sands might yield oil, plus a reasonable option price, prompted exploration. The Bahrein Petroleum Company was formed, and subsequent years proved that not just an option to an island had been bought, but also a veritable ocean of oil. Production on Bahrein, structurally composed by one anticlinal dome, began in 1933. Oil comes entirely from the one field in the central portion of the island.

Saudi Arabia. The earlier geological studies at Bahrein suggested the possibility of oil on the Arabian mainland, a short distance across the Gulf of Selwa. California Standard obtained a concession there in 1933 and formed the Arabian American Oil Company, usually referred to as Aramco. In 1936 the Texas Company became an equal partner in both the Bahrein and Arabian American Companies. The total Aramco concession now covers some 450,000 square miles, about equal in extent to the states of Texas and California combined. It comprises an irregular area which begins not far from the head of the Red Sea and extends Southeast through Saudi Arabia to the western shore of the Persian Gulf, thence southward to include a large part of southern Saudi Arabia.

Following years of exploratory and drilling work, commercial production began in 1938. Just prior to World War II there was one field, the Dammam, with a total of twenty wells. Today five fields exist with a total of sixty-two wells (Fig. 2). In 1939 Aramco produced about 9,000 barrels of petroleum per day. Now daily production nears the 300,000 barrel mark.

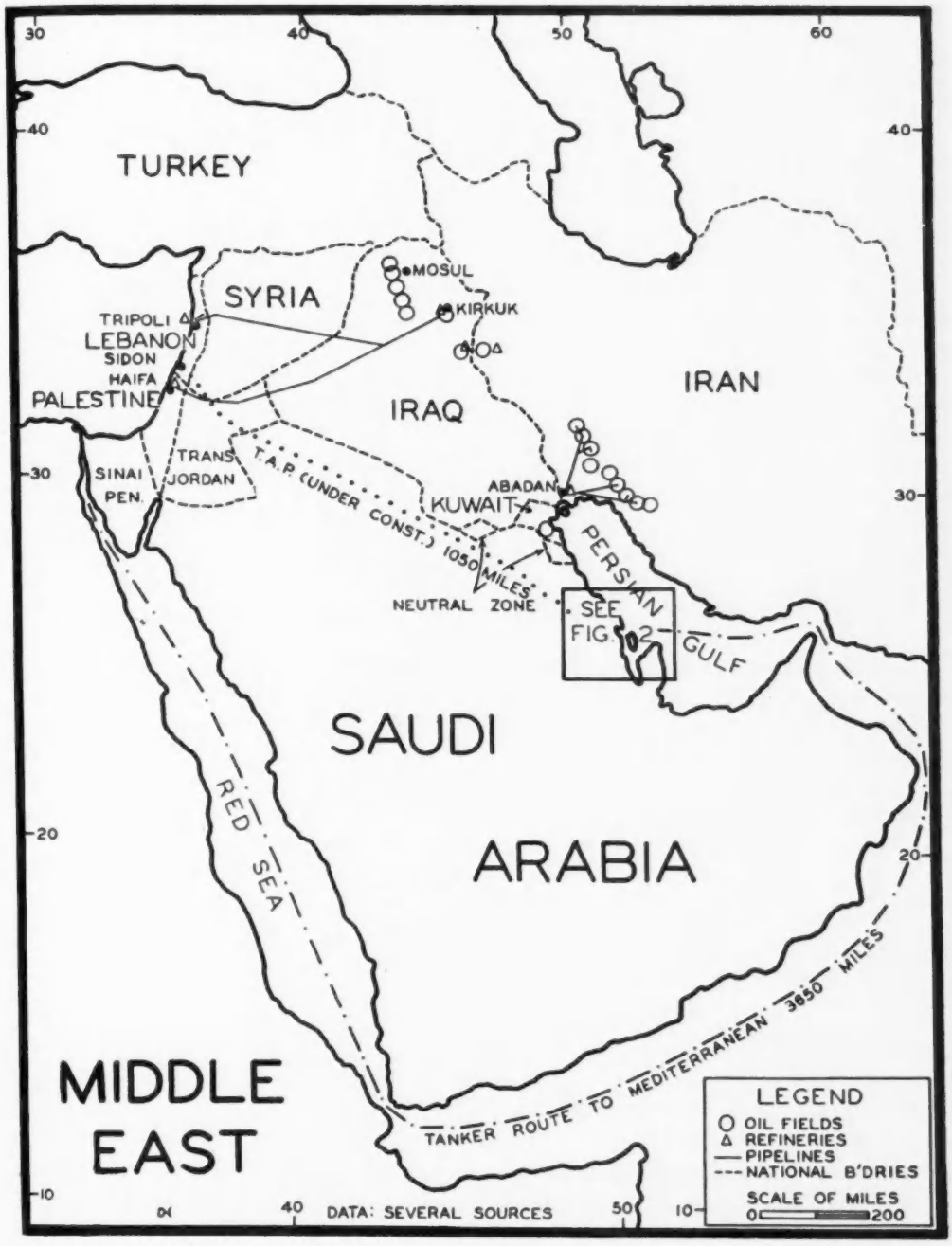

FIGURE 1.—Within Saudi Arabia, Iran, Iraq, and Kuwait lies 40 per cent of the world's known oil reserves. Note the regional relationship of the Arabian fields (inset) to the other fields in the Middle East.

FEATURES OF DEVELOPMENT

Nature of Region. Shifting sand dunes, found for the most part in the immediate vicinity of the Persian Gulf, break off near the shore into salt marsh and sandy beach. Extending inland

from the dunes for hundreds of miles stretch rolling, unbroken, hard-surfaced plains at elevations ranging from 1,000 to 2,000 feet. Rainfall in the entire region does not exceed four inches per year, consequently drainage is accommodated by occasional shallow wadies or "dry" water courses. Vegetation is so sparse that it may be said to be nonexistent. The thin veneer of nomadic Bedouin tribes reflects the aridity. There are no railways, highways, or improved trails. None are required because in most of the areas traversed, except where there are outcrops of disintegrated stone, the surface is sufficiently stable and uniform to sustain vehicular traffic without grading or surface improvement. The wadies present minor obstructions to travel. In many respects the region resembles the plateau region of northern Mexico and the Permian Basin area of West Texas and New Mexico.

Worst of all is the heat. Temperatures of 120° F. in the shade occur on many summer days and sometimes reach 160° F. in the sun. Winter temperatures, by contrast, fall as low as 20° F. The pioneer geologists in the area not only suffered from the heat, but also the humidity, flies, dysentery and lack of adequate housing.

Twelve Years of Changes. Dhahran, once a "wildcat" camp, has become a modern comfortable community. All the houses, offices, and community buildings are air-conditioned. The company provides its employees with water, electricity, gas, and telephones. Irrigation furnishes the basis for trees, grass, and flowers around the settlements.

FIGURE 2.—Arabian area of petroleum development in Hasa Province bordering the Persian Gulf.

TABLE I

A COMPARISON OF THE DAILY PETROLEUM PRODUCTION OF THE FOUR LEADING AREAS AND THE REST OF THE WORLD FOR THE YEARS 1941 AND 1946

Area	*Barrels Daily*		*Percentage of World Total*	
	1941	*1946*	*1941*	*1946*
United States	3,841,721	4,749,107	63.1	63.00
Caribbean Area (Venezuela, Colombia, Trinidad)	749,285	1,177,482	12.3	15.62
MIDDLE EAST	204,195	690,449	3.4	9.16
Soviet Russia	652,466	438,227	10.7	5.81
Rest of World	642,582	482,820	10.5	6.41
World Total	6,908,249	7,538,085	100.0	100.00

The employees have their own fresh-water swimming pool, golf course, tennis courts, and club houses. The same air-conditioned living and community buildings are found at Ras Tanura about forty miles northeast of Dhahran on a sandy coastal spit. A modern hospital with skilled surgeons is found at both centers of activity. The power plant at Ras Tanura, one of the most modern industrial plants in the Eastern Hemisphere, supplies Dhahran as well as Ras Tanura. Native Arab workmen live in comfortable quarters adjoining the American camps. Most of the native foremen's quarters are also air-conditioned.

Due to the shallow coastal waters, special wharves were projected far out from shore to load large tankers efficiently. One of these is at Ras Tanura, the other off Sitra Island for the Bahrein output. Each marine terminal handles four tankers at once. The average tanker loads in about twelve hours. The longest submarine pipe line in the world underlies the Gulf of Selwa between the mainland and Bahrein Island. Before its construction, and the construction of the mainland refinery, Arabia's entire output had to be barged to Bahrein.

The heat besides making air conditioning highly desirable, if not necessary, necessitates other special technological developments or adaptations. The effect of heat and sand upon ordinary automobile tires brought into existence a special type of oversize, heat-resistant tire. Contraction and expansion, incident to wide atmospheric temperature changes, requires unusual precision in large diameter pipe-line construction. Deep-water well drillings make possible the year round use of desert trails that formerly could not be traveled during summer months.

Effect of World War II. In 1940 Aramco's facilities were actually bombed by the Italians, and, as the Germans advanced in Africa, British pressure to destroy the wells resulted in the plugging of many of them with cement. Stagnated production figures for the next couple of years illustrate the temporary setback to development (Table III). In 1943 the tide turned violently the other way. With Africa safe, and the war spreading out in Europe and Asia, demand for oil became insatiable. The large refinery at Ras Tanura was approved and rushed through as a war project along with the rapid expansion of other facilities. The stimulas for development received in 1943 has been going forward since with ever-increasing momentum.

TABLE II

MIDDLE EAST PROVEN CRUDE OIL RESERVES

(bil. barrels)

Country	*Crude Res.**	*Crude Res.***	*Percentage of World Total**	*Percentage of World Total***
Iran	9,500	7,000	13.80	10.44
Iraq	7,500	5,000	10.90	7.46
SAUDI ARABIA	6,000	5,000	8.72	7.46
Kuwait	5,000	9,000	7.26	13.43
Bahrein Is.	300	275	.43	.41
Qatar	250	1,000	.36	1.49
Middle East Total	28,550	27,275	41.47	40.69
United States†	21,345	20,874	31.02	31.14
Venezuela†	8,500	7,000	12.35	10.44

*1947 World Oil Atlas published by *The Oil Weekly*, June 30, 1947, p. 35.
***Oil and Gas Journal*, Vol. 46, No. 34 (Dec. 27, 1947), p. 268.
†For comparative purposes.
• NOTE: In a *Fortune* article, Vol. 35, No. 5 (May, 1947) titled "The Great Oil Deals," Saudi Arabia and Bahrein Is. combined are shown graphically as possessing both the largest proved and largest potential reserves in the Middle East.

FIELDS AND WELLS

The appearance which the wells give as their derricks rise in the distance is one of sparseness as compared with the multitude and proximity of wells at Long Beach, California. In the Abqaiq field, for example, wells, drilled two miles apart and silhouetted against a stage of drifting sands and rocky plains, provide the most unique feature of the Arabian fields. Table IV shows recent production data for the various fields, while Table V gives the geological and engineering data on Saudi Arabia.

Dammam. This oldest and second largest producing field is located directly opposite the northern end of Bahrein Island. The first well in Saudi Arabia, put down in April, 1935, produced nothing but disappointing results as did the next eight wells, all located in the Bahrein zone. After three years of defeat, the Arab zone was struck at 4,500 feet and commercial production achieved. The Dammam field production comes almost entirely from this deeper layer. Only two of its 33 flowing wells draw from the Bahrein zone. Dhahran, the focal point of the approximately 180 square mile development area and headquarters of Aramco, is located in the center of this field.

Abqaiq. The largest producing field in Saudi Arabia lies about 40 miles southwest of Dammam. Its 24 flowing wells range in depth from 6,100 to 7,400 feet. The upper zone, about 90 feet thick, covers approximately 10,000 acres while the lower zone, of 235 feet thickness, covers a greater area. This field presents the most intensive present drilling activity and serves as the starting point of the great Trans-Arabian pipe line to the Mediterranean now under construction.

Qatif. Located approximately 17 miles north of Dammam, the two-well Qatif field has a daily output of some 4,500 barrels. Two zones, the upper about 110 feet thick and the lower of approximately 215 feet, embrace several thousand acres. The entire Qatif output goes to Ras Tanura, whereas the Dammam and Abqaiq crude petroleum feeds both Ras Tanura and Bahrein. A 40 mile underwater pipe line connects Bahrein with the mainland.

Abu Hadriya and Buqqa. The Abu Hadriya field, situated about 100 miles northeast of Dammam, has completed one well at about 10,000 feet, at present

TABLE III

MIDDLE EAST CRUDE PRODUCTION HISTORY

(thousand barrels of 42 U. S. gallons)

Year	*Bahrein*	*Iran*	*Iraq*	*Kuwait*	*SAUDI ARABIA*	*Total Middle East*
1913	.....	1,857	.....	.....	.....	1,857
1914	.....	2,910	.....	.....	.....	2,910
1915	.....	3,616	.....	.....	.....	3,616
1916	.....	4,477	.....	.....	.....	4,477
1917	.....	7,147	.....	.....	.....	7,147
1918	.....	8,623	.....	.....	.....	8,623
1919	.....	10,139	.....	.....	.....	10,139
1920	.....	12,230	.....	.....	.....	12,230
1921	.....	16,673	.....	.....	.....	16,673
1922	.....	22,247	.....	.....	.....	22,247
1923	.....	25,230	.....	.....	.....	25,230
1924	.....	32,373	.....	.....	.....	32,373
1925	.....	35,038	.....	.....	.....	35,038
1926	.....	35,842	.....	.....	.....	35,842
1927	.....	39,842	338	.....	.....	40,026
1928	.....	43,461	713	.....	.....	44,174
1929	.....	42,145	798	.....	.....	42,943
1930	.....	45,828	913	.....	.....	46,741
1931	.....	44,376	830	.....	.....	45,206
1932	.....	49,471	836	.....	.....	50,307
1933	31	54,392	917	.....	.....	55,340
1934	285	57,851	7,689	.....	.....	65,825
1935	1,265	57,273	27,408	.....	.....	85,946
1936	4,645	62,718	30,406	.....	20	97,789
1937	7,762	77,804	31,836	.....	65	117,467
1938	8,298	78,372	32,643	.....	495	119,808
1939	7,589	78,151	30,791	.....	3,934	120,465
1940	7,074	66,317	24,225	.....	5,075	102,691
1941	6,794	50,777	12,650	.....	4,310	74,531
1942	6,241	72,256	19,726	.....	4,530	102,753
1943	6,572	74,612	24,848	.....	4,868	110,900
1944	6,714	102,045	30,943	.....	7,794	147,496
1945	7,309	127,407	32,349	.....	21,311	188,376
1946	8,010	144,896	32,777	5,990	60,341	252,014
1947*	8,760	159,300	35,040	20,075	90,000	313,760
Total	87,349	1,747,542	378,676	26,065	202,743	2,442,960

*Estimated.

Sources: Mineral Resources and Minerals Yearbook.
1947 World Oil Atlas published by *The Oil Weekly*, June 30, 1947, p. 31.
Oil and Gas Journal, Vol. 46, No. 34 (Dec. 27, 1947), p. 156.

idle for lack of a pipe-line connection to Ras Tanura. Renewed activity will soon begin at Abu Hadriya where data shows the first well drilled lies some five miles from the crest of the structure. The Buqqa field, the most recent discovery, located about twenty miles northeast of the center of Abqaiq, completed two wells in 1947 and awaits pipe-line connection before it can contribute to the country's output. Present estimates suggest an area upwards of 2,000 acres in the Buqqa field.

An interesting comparison exists between the per well yield in the United States and Saudi Arabia. The United States at the close of 1946 had 424,286 producing wells with a net flow of only 11.1 barrels per well. In addition over three-fourths of these wells were in the pumped or artificial lift category. At the same time Saudi Arabia's 41 flowing wells had an average daily production of 5,236 barrels per well. One authority states that Saudi Arabia's wells yield about two-thirds as much oil as 24,000 wells in East Texas.

Several outstanding features may be

TABLE IV

PRODUCING WELLS AND OIL PRODUCTION OF SAUDI ARABIA AND BAHREIN ISLAND

Name of Field	*No. of Wells at End of 1947*		*Crude Oil Production (Barrels)*				*Wells Drilling*
	Flowing	*Pumping*	*Year 1945*	*Year 1946*	*Daily Av. Prod.*	*Accumulative Prod.**	
Saudi Arabia:							
Abqaiq	24	..	17,455	24,783,738	160,000	45,000,000	3
Abu Hadriya	1	..	Shut in—No Pipe-line Connection				..
Buqqa	2	..	Shut in—No Pipe-line Connection				1
Dammam	33**	..	21,124,381	34,585,118	100,000	105,000,000	..
Qatif	2	..	169,160	971,806	4,500	1,700,000	1
Total	62	..	21,310,996	60,340,662	264,500	151,700,000	5
Bahrein Island:							
Bahrein	67	..	7,308,938	8,009,802	26,000	83,063,662	..

*To July 1, 1947. **Includes one gas well.

TABLE V

ENGINEERING AND GEOLOGICAL DATA ON SAUDI ARABIA AND BAHREIN ISLAND

Name of Field	*Year of Discovery*	*Est. Proved Area (Acres)*	*Gravity of Oil API*	*Producing Formation*				
				Local Name	*Kind*	*Geological Age*	*Prod. Depth*	*Type Structure*
Saudi Arabia:								
Abqaiq	1940	11,000	37.5	Arab	Lime	Upper Jurassic	6,900	Anticline
Abu Hadriya	1940	6,500	35.5	Hadriya	Lime	Upper Jurassic	10,220	Anticline
Buqqa	1947	2,000	35.0	Arab	Lime	Upper Jurassic	7,169	Anticline
Dammam	1936	9,000	35.0	Bahrein	Lime	Cretaceous	1,600–2,300	Faulted
				Arab	Lime	Upper Jurassic	4,900	Anticline
Qatif	1945	2,000	37.0	Arab	Lime	Upper Jurassic	7,500	Anticline
Bahrein Island:								
Bahrein	1932	10,000	31.0	Bahrein	Lime	Cretaceous	1,900–2,300	Elongated Dome

Sources for Tables IV and V: 1947 World Oil Atlas published by *The Oil Weekly*, June 30, 1947, *Oil and Gas Journal*, Vol. 46, No. 34 (Dec. 27, 1947).

TABLE VI

MIDDLE EAST REFINERIES

Refinery	*Crude Capacity (bbl. daily)*	*Cracking Capacity (bbl. daily)*	*Type of Refinery*
Abadan, Iran	420,000	125,000	S-C-A
BAHREIN, BAHREIN IS.	125,000	23,600	S-C*
RAS TANURA, SAUDI ARABIA	115,000	14,000	S-C
Haifa, Palestine	63,000	33,000	S-C-A
Alwand, Iraq	6,900	None	S
Kermanshah, Iran	2,100	None	S
Baba Gurgur, Iraq	1,500	None	S
Tripoli, Lebanon	1,500	None	S

*Asphalt-manufacturing facilities are to start early in 1948.

Source: *Oil and Gas Journal*, Vol. 46, No. 34 (Dec. 27, 1947), pp. 200–213.

noted about Saudi Arabian field developments. First, there is only one operating company in Saudi Arabia, and from all indications this situation will remain. Secondly, there are no small claims to deal with or jealous property owners demanding costly "offset" drilling. Production costs are the lowest of any major producing region in the world.

REFINERIES

Of the eight refineries now in the Middle East, Bahrein and Ras Tanura rank second and third respectively in total daily crude oil and cracking capacity, surpassed only by the great Anglo-Iranian Abadan plant, the world's

FIGURE 3.—Aerial photo of well in Abqaiq field. Distances between wells in this field are approximately two miles. (Courtesy of Arabian American Oil Co.)

largest, situated at the head of the Persian Gulf. (Table VI.)

Bahrein. This second largest refinery in the entire Middle and Near East is located along the Eastern side of Bahrein Island facing Sitra Island. The original refinery, constructed in 1936, handled the output of the Bahrein field. Increasing commercial quantities coming from the mainland demanded installation enlargements. Despite the modern refinery and loading wharf at Ras Tanura, Bahrein still provides the outlet for more than one-third of the total output from the Arabian fields through the twelve-inch submarine pipe line from Dammam.

Ras Tanura. Only since the War have large scale refining operations been carried on in Saudi Arabia. A small

FIGURE 4.—Bahrein Refinery on Bahrein Island in the Persian Gulf. Note the flattish terrain and shallow coastal-water features in the background. This refinery is the outlet for almost one-third of the Arabian crude production. (Courtesy of Bahrein Petroleum Co.)

plant with a 3,000 barrel daily capacity has existed since the fall of 1940. Operations were discontinued in 1945 upon completion of the present 60 million dollar installation. The Joint Chiefs of Staff having approved the use of materials for this project in 1943, the new refinery was rushed to completion in a year and one-half with a laboring force of about 12,000 men. While rated in advance to have a capacity of 50,000 barrels daily, it actually operates at a daily rate of 115,000 barrels.

Aramco has a large stabilizing plant at Dhahran to sweeten Abqaiq crude for shipment. Arabian crude with a rather high hydrogen sulfide content must be reduced before it can be sent out as crude.

TAPLINE

At the present time work progresses upon the largest pipe line in the world. The Trans-Arabian Pipe-Line Company (Tapline), a subsidiary of the Arabian American Oil Company, is constructing a 30 and 31 inch line from the Abqaiq field to Sidon, Lebanon, about 30 miles south of Beirut. Upon completion, scheduled for late 1949, this giant of crude oil transport will have a daily capacity of 300,000 barrels, and will cut off approximately 2,650 miles from the marine tanker route around the penin-

sula and through the Suez Canal to the Mediterranean (Fig. 1).

Leaving Abqaiq, the pipe line will pass out of the sands after a few miles and then cross open stony desert and rolling, unbroken, hard-surfaced plain. From just north of the Transjordan border it will run into the Harrar: the lava beds. Beyond, and near the Mediterranean coast, the line will cross low passes in the Lebanese and Anti Lebanese Mountains inland from Sidon. Perhaps one-third of the line will be constructed above ground, where hard rock prevents trenching. Due to isolation, the pumping stations, which are being built about 175 miles apart, must be complete communities provided with water supply, schools, mosque and churches, commissary, housing, recreational, and hospital facilities.

No large bays or other well protected natural harbors exist along the entire Mediterranean coast, east or northeast of Alexandria, Egypt. Fortunately, meteorological records indicate that, except for a few days during two winter months, gales and storms on the east Mediterranean coast are not severe enough to interfere with coastal navigation. As a result, at Sidon, a concrete pier now under construction reaches births for loading tankers in six fathoms of water about 2,000 feet from the shoreline. Tankers will load by gravity from a tank farm on high ground behind the pier.

During 1947, in connection with the financing of this giant pipe line and other expansion projects, the Arabian American Oil Company took on its present character of capital control. The Standard Oil Company of California, the Texas Company, and the Standard Oil (New Jersey) hold 30 per cent each. The remaining 10 per cent belongs to the Socony-Vacuum Oil Company.

VALUE OF DEVELOPMENT TO ARABIA

Under the magic touch of royalties from petroleum developments, the Middle East, within the limitations imposed by pronounced aridity, transforms itself into a new land of plenty and prosperity. That cradle of civilization between the Red Sea and Persian

FIGURE 5.—Part of the new mainland refinery at Ras Tanura, a wartime emergency project. (Courtesy of Arabian American Oil Co.).

Gulf—dormant for one thousand years—awakens to a new life, and the key which opens the marvels of the modern age to it is oil.

Royalties on the Arabian American Company's concession amount to four gold shillings per ton, approximately 23 cents per barrel. As a result of this expanding income, Saudi Arabia's program of modernization becomes one of the most extensive of any country on earth today. The amount that will be spent upon all internal projects within the next four years is 27 times that nation's pre-war budget. According to present estimates of the country's income, by 1951 Saudi Arabia will receive 50 million dollars annually from oil—a sum more than the total of any other Arab state, except Egypt. Future construction plans call for railroads, motor roads, ports, electrification projects, irrigation and farm development, schools and hospitals. These projects, not awaiting actual earnings, progress at present from loans against future earnings. This modernization work affects most of the country's five million subjects.

SUMMARY

Fourteen years ago, no one surmised that oil existed beneath the hot sands of Arabia. Today 58 wells produce an average of nearly 300,000 barrels daily. A 140 million dollar industry now exists in a region recently a wasteland.

Great changes are rapidly taking place as to world sources of petroleum and the direction of flow of this strategically critical raw material in international trade. The United States for the first time in history is rapidly becoming a net importer of petroleum.

The Middle East, now ranking third as a major world source region, seems destined within perhaps the next decade to lead the world as a supplier of this precious raw material. Saudi Arabia will have an important place in this development.

SEQUENCE OF PLANTATION AGRICULTURE IN CEYLON

Shannon McCune

THE economy of Ceylon is dominated by its plantations. Plantations because of the physical requirements of their crops have been located mainly in the less-accessible hill country of Ceylon. Their prosperity, however, reflects conditions that prevail in other parts of the world where there is competitive production or where their markets are located. If the plantations in Ceylon are in an advantageous position either for production or markets, the economy of the island as a whole is prosperous. The daily life of the six million people of Ceylon is therefore greatly, though indirectly, influenced by the plantations. In the coming years, as Ceylon becomes a more independent member of the society of nations, the role of the plantations in the island's economy will be of even greater significance.

Plantations have gone through an interesting historical sequence. The physical factors of land of course have not changed, but external economic and political controls have changed and diseases have been imparted. These have been instrumental in guiding the type of products cultivated in Ceylon. At present tea, rubber, and coconuts are the primary plantation crops. For rubber and tea international control schemes, tuned to world economic conditions, are operating, and by their functioning control production in Ceylon. If these schemes break down and Ceylon is forced to compete on an open market, many changes may take place in the economic geography of the island. Thus the study of the changing plantation economy of Ceylon provides an eloquent example of the interdependence of different parts of our world.

Cinnamon

Ceylon's "spicy breezes" have long been known to the western world. Cinnamon, the spice for which Ceylon was best known, was obtained by Arab and other traders and, after passing through the hands of many middlemen, finally reached Europe. The Portuguese when they first came to the island early in the 16th century found, therefore, that cinnamon was one of the best export items obtainable in the island. Most of the cinnamon was gathered in the forests held by the Kandyian kings, and the Portuguese were able to obtain certain amounts of it each year. The Dutch, who gained control of the coastal area from the Portuguese in 1658, though continuing to buy cinnamon from the hill areas, started the cultivation of the crop themselves. It was found that, after cutting the trees down, the shoots which would sprout were easily peeled of their bark. Thus under the Dutch East India Company a few large plantations and numerous native gardens were started along the coast.

With this production, plus the control they exercised over the buying and export of cinnamon from the hill regions, the Company was able to hold a world monopoly on cinnamon which at that time commanded a high price as a food preservative in Europe. The British kept this monopoly when they took

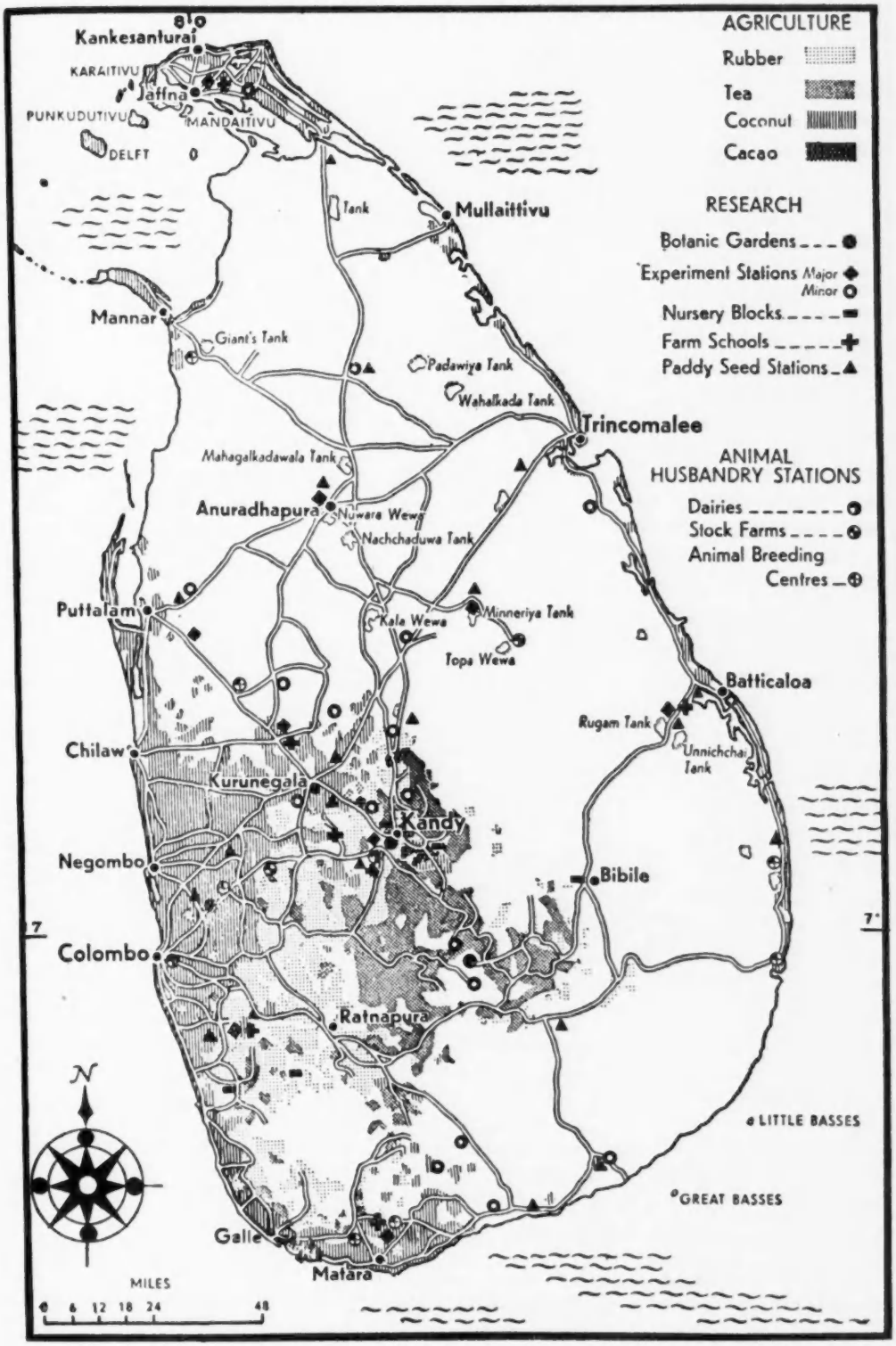

FIGURE 1.—Major production areas of plantation crops in Ceylon. (Map, courtesy of British Information Service.)

over the islands from the Dutch in 1796. In the early years there was considerable manipulation of the trade which was under control of the British East India Company. In 1821 the monopoly was taken over by the Government. By restricting output to roughly 400,000 to 500,000 pounds, the estimated world consumption, the Dutch and British had been able to maintain an artificially high price for the cinnamon, and it was a very profitable revenue. However, during the early part of the 1800's, cultivation of poorer grades of cinnamon began in India and Java, and a substitute for cinnamon, cassia, which was grown throughout southeast Asia, began to come on the market. Though the monopoly was abolished in 1833, a heavy export duty was substituted. Because of the competition of other areas and products, the price began to fall. The high standards of Ceylon cinnamon were not kept up. Though the export duties were gradually lowered and finally abolished in 1853, it was too late to save the plantation industry. It went into the hands of native Singhalese cultivators and became a minor cash crop. Today there are roughly 26,000 acres in cinnamon gardens located mostly in the southwestern part of the island.

COFFEE

As cinnamon decreased in importance as the major export, a new product began to emerge, coffee. The hilly lands of Ceylon were well suited to its cultivation, but so long as the Kandyian kings held this area and transportation was poor the industry could not get a start. However, a century ago under the remarkable engineering skill of Major Skinner, military roads were built for the suppression of the Kandyian kings. These opened up the hill lands and thus made possible the development of the coffee industry. The increasing demand in Europe coupled with the decline of production in the West Indies gave Ceylon a good competitive position. The boom started in 1835. Public land was cheap. Though a lot of the clearing was purely speculative, extensive areas were planted to coffee. The center of activity was the hill land around Kandy. There was the necessity for considerable capital in clearing the dense tropical forest, and planting the coffee trees and waiting for their maturing. Skilled laborers and scientific methods of cultivation were lacking. The speculation bubble burst in 1847 because of these factors, but the industry recovered and was prospering again by 1853. Tamil laborers were brought in from southern India and the financial structure of the

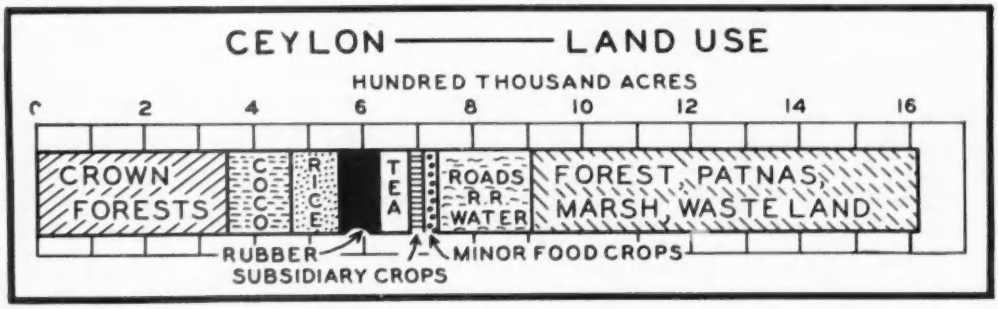

FIGURE 2.—Total L. Use in Ceylon. A relatively small percentage of the land is given over to the plantation crops and rice.

plantations was put on a sound footing. By 1857 there were 404 plantations with an area of 86,950 acres of which 63,771 acres were in bearing trees and 17,179 were in planted trees. In addition there were 10,000 acres of plantations which had been abandoned and were being reclaimed and 48,000 acres owned by natives. In 1867 the area in European plantations increased to 168,000 acres and in 1878 the maximum of 275,000 acres was reached. Coupled with the expansion was the building of more and better roads. In 1867 the railroad from Colombo to Kandy was completed; in later years the lines were extended further into the plantation area. The new breakwater at Colombo harbor was started in 1873, and this 12-year project served to make Colombo (rather than Galle) the major part.

In 1868, a fungus growth developed, and in an area devoted so exclusively to one crop the fungus quickly spread. In a few years production began to decline. The new areas that were planted to coffee did not match the decline and were themselves soon blighted. At the same time Brazil, unaffected by the disease, began to compete and forced European prices down. Credit was difficult to obtain, and the Ceylon coffee industry collapsed. Acreage decreased sharply. By 1895 there were only 22,475 acres in coffee; ten years later, only 3,591 acres. Today, a few cleared forest lands are mute symbols of a once important phase of land utilization.

CINCHONA

Just as coffee replaced cinnamon in the agricultural export economy, so new crops—cinchona and tea—took the place of coffee. Government scientists had been experimenting since 1861 with cinchona, from which quinine is derived. The planters as their coffee trees were blighted started planting the new product, for which there was a great world demand but little production. Acreage increased from 500 in 1872 to 65,000 acres with 60,000,000 trees by 1883. But this great increase in Ceylon's production, coupled with production in other areas, exceeded the demand, and the world price of cinchona fell sharply. Production in Ceylon began to fall and many of the trees were pulled up to make room for tea. In 1893 there were from 7,000,000 to 8,000,000 cinchona trees; by 1902 the cinchona industry was of only minor importance.

TEA

The plantation crop which next became established in Ceylon was tea. The bushes grew well on the poor but well-drained soils of the central hill slopes at elevations from 2,500 to 6,000 feet, the finer grades growing at the higher elevations. The heavy rainfall was a decided benefit rather than a handicap. One of the major difficulties was a plentiful supply of skilled but cheap labor. There was a continuing immigration of Tamils from southern India on to the plantations. The area devoted to tea increased rapidly from 1,000 acres in 1875 to 406,000 acres in 1903. The newer plantations were not centered around Kandy but were located further to the south and east, in areas at higher elevations that had been made accessible by newly constructed rail lines. Because of the rapid increase of production, the price, which had been very high, fell. This stopped the additional widespread planting of tea bushes shortly after the start of this century and forced the submarginal producers in the more inaccessible and poorer areas to give up. Many of the tea estates were amalgamated under the ownership of London controlled companies. Large central factories for the

FIGURE 3.—Tea Estate in the hills of Ceylon. The tea bushes on the precipituous slopes surround the factory and associated buildings. (Courtesy of British Information Service.)

processing of tea were established. Funds and effort were put into research as to the best types of tea bushes and the best methods of cultivation. Ceylon tea is of uniform high quality and is used as a blend with India teas. It is because of its excellent quality that Ceylon is able to compete with some of the other tea areas of the world where physical conditions are better and labor costs are lower.

During the early part of this century, after the tea industry of Ceylon had become stabilized, it was quite prosperous; the increasing demands were not overrun by increasing production. During the First World War, wartime controls were exercised by the British government. When they were lifted there was a boom that quickly led to overproduction. Therefore, in 1920 and 1921, a voluntary restriction plan was put into effect by the British-dominated tea industry. This, coupled with a falling off of production due to adverse natural conditions, brought about a drop in the stocks of tea held in London, so that the crisis was weathered. During the middle 1920's good profits were being made and the planters and traders were very optimistic about the future of tea. The world-wide depression of 1929–1932, however, dashed these hopes and led to further valorization schemes. Finally, in 1933, there was set up the Internation Tea Agreement, encompassing India, Netherlands Indies, and Ceylon. These areas controlled 80 per cent of the world exports of tea. Quotas were set for each area, and Ceylon was alloted on the basis of its 1929 production about one-third of the total. This agreement was to run for five years but has been continued beyond that period.

Under the quota plan the area of tea in Ceylon has become standardized at around 550,000 acres. The yields vary from year to year depending on the quotas to a greater extent than on natural conditions. During the War years with Netherlands Indies production not available, more leaves were picked, and in 1944 276,000,000 pounds of tea were produced. This was 50 million pounds more than the pre-war average.

FIGURE 4.—Tamil women and men at work plucking tea on a rocky hill slope in Ceylon. The tea is put in the baskets held on their backs by a head band. (Courtesy of British Information Service.)

Most of the commercial tea is produced on the plantations. These plantations with their fields of tea bushes, often planted under shade trees which are later cut down, are characteristic of the hill region. The factories where the tea is withered, rolled, fermented, fired, and graded are surrounded by the native laborers' homes, usually long rows of barrack-like buildings. In 1946 there were 2,308 plantations in Ceylon averaging roughly 200 acres in size and covering

487,801 acres. Four-fifths of the plantations are owned by British capital. In addition, 76,190 small native-owned holdings with an acreage of 61,824 acres produced tea for local consumption. There were 383,498 Indian laborers and 69,810 Ceylonese laborers on these estates. (Data from *Post-War Development Proposals, 1946*, Government Record Office, Colombo, 1946.)

Labor is the major cost in tea production. The labor costs are subdivided into cost to labor for cultivation, 25 per cent; plucking, 10 per cent; native supervision and manufacturing, 15 per cent; and European supervision, 10 per cent. The distribution, packing, freight, and profit account for the other 40 per cent of the production costs. One of severest handicaps to the tea industry in Ceylon has been the skyrocketing prices of food which the plantations must import for their workers.

Tea now controls the commercial economy of the island. It furnishes three-fifths of the value of Ceylon's exports. In 1947 tea contributed over £10,000,000 in export duties and taxes to the Ceylon exchequer. Roads and railroads have been built and maintained to serve the estates. The port of Colombo is geared to exports of tea and imports of food and manufactured articles. The continuance of the tea industry in Ceylon depends in large part on the availability of cheap labor and on the maintenance of a competitive position either through a quota system or through lower costs.

RUBBER

After tea, the most important of the purely plantation crops is rubber. It actually occupies more area, 653,917 acres. Rubber trees had their first flowering in Ceylon in 1881. The industry had a very slow start, due to lack of experience, competition with tea, and small demand. However, after the turn of the century, Ceylon had a great development of rubber production. Acreage increased from 1,750 in 1900, to 188,000 acres in 1910, to 460,643 acres in 1920, to 582,247 acres in 1930, and to 636,936 acres in 1940. The planting took place mainly in the hot, moist southwestern part of the island, usually below 2000 feet in elevation, where the rainfall is over 80 inches a year.

The industry has had great fluctuations. During the early years, profits were large for all the producers. However, after World War I, overproduction, coupled with a slump in markets, created a grave crisis not only for Ceylon but for the other British-controlled producing areas. Under the Stevenson plan of 1922, exports were curtailed and prices thereby raised slightly. But, another major setback came in the world-wide depression of the early 1930's. This led to the establishment in 1934 of the International Rubber Regulation Committee, which set up quotas for the various member countries. The plan also restricted the planting of new rubber trees. This restriction was lifted in 1938, but

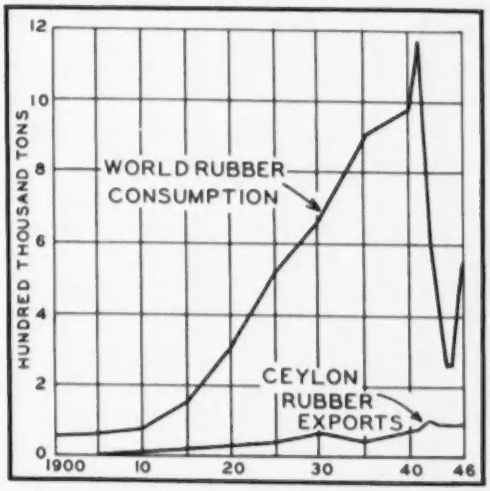

FIGURE 5.—The recent fluctuation in the value of plantation products in Ceylon. (Source: Post-war Development Proposals, Ceylon, 1946.)

actually little new planting took place in Ceylon. Only 66,521 acres, most of which were in small non-estate holdings, were newly planted. Consequently, it is estimated that the average age of the trees in Ceylon is over 35 years, a ripe old age as productive rubber trees go.

During World War II it was fortunate that Ceylon was able to supply the Allies with such a significant portion of their raw rubber. To do so, the island's rubber industry was severely taxed. Various incentives were given for increased production—prices were raised eventually to double the 1942 figure and bonuses were given for production over averages. A plan adopted in 1943 to compensate those owners who slaughter-tapped their trees over a two-year period was not popular. Only the trees on 95,676 acres were so tapped. Nevertheless, during the War years production approached its peak both in tonnage and value.

The plantation rubber industry faces an uncertain future. Competition from other areas, particularly those where natives can produce very cheaply, and competition from synthetic rubber production will be severe. Solutions for Ceylon's dilemma lie in having an increased demand at a sufficiently high price so that the island can continue to maintain a share of world quotas, or in modernizing and increasing the efficiency of Ceylon's rubber industry so that it can maintain a competitive position. Especially needed is a program of planting modern, high-yielding trees in the heavy rainfall areas where elevations are below 500 feet. Trees at higher elevations are likely to be attacked by the oidium leaf disease, because of the low night temperatures there.

The industry is carried out with varied sized holdings, many of which are not economical. There were, in 1947, 833 estates with acreages over 100 acres and an average size of 427 acres. In the early days, rubber estates of 250 acres were able to carry a well-paid European resident manager and were completely self-contained units. Today, however, units of 2000 to 3000 acres are more economical, yet only 10 estates are over 2000 acres in area and another 57 between 1000 and 2000 acres. Using fairly conservative estimates of prices and costs and allowing a yield of 400 pounds per acre, the Ceylon Rubber Industry Commission in 1947 judged that 103,619 acres of the 356,297 acres in estates were noneconomic. The smaller holdings, 10 to 100 acres, of which there were 5,372, had a total area of 134,022 acres of which 34,702 acres were noneconomic, even allowing for a yield of only 250 pounds per acre. Finally, the very small holdings, often only a few trees in a garden, less than 10 acres in size, of which there were 104,933 holdings, having a total acreage of 146,617, had 35,204 acres of non-economic rubber. Much of the rubber was uneconomical because of the oidium leaf disease, which affected an estimated 111,000 acres of the 175,000 acres of uneconomical rubber. This extent of uneconomical rubber was, in addition, increasing rapidly and was expected to reach a total of 200,000 acres within a year or two.

Another problem facing the rubber industry is that of labor supply. The estates particularly face an increased labor cost. Perhaps this is just retribution, since the labor conditions of three decades ago were not far from slavery, for the laborers were kept heavily in debt. The situation has been changed by more enlightened labor laws. Labor costs spiralled during the War. The increase of wages for 503 estates with a total area of roughly 250,000 acres from 1939 to 1946 was from Rs. 5½ to 25; in 1939 labor was 37 per cent of the

FIGURE 6.—A rubber curing factory in Ceylon. In the foreground are some rubber trees and other trees may be seen on the hillcrest. (Courtesy of the British Information Service.)

cost of production, in 1946 it was 48 per cent. The legal minimum wages were set in 1947 at Rs. 1.37 per day for men and Rs. 1.08 for women, though a sampling of actual wages was higher: Rs. 1.65 (roughly U.S. 50 cents) for both men and women. The workers would become more efficient through time-saving devices, better utensils, different systems of cutting, and better organization. A time study of 54 tappers made by the Rubber Commission is revealing in this regard. It is summarized in the following time table:

6.06 a.m.	Leaves his lines for the trees
6.24	Arrives at trees
6.27	Taps first tree (205 trees on the half cut or 122 trees on the double cut)
10.06	Taps last tree
	Rest and time for latex to gather
10.30	Collects from first tree
11.22	Collects from last tree
11.23	Walks to factory with latex
11.47	Arrives at factory
12.21	Leaves for lines after waiting and being weighted in a factory

Actual working time: 6 hours and 15 minutes
Actual tapping time: 3 hours and 39 minutes
Actual collecting time: 52 minutes

The number of days spent in tapping in Ceylon is considerably less than in Malaya. In Ceylon the trees are "rested" from February 15 to March 15, a practice developed by custom rather than necessity. Tapping takes place on Sundays only when the weather is very favorable, so that 16 days are lost; holidays when no tapping takes place number 12. Due to the heavy rainfall an average of 35 days are lost. Thus tapping occurs only 274 days a year in contrast to Malaya's average of 335 days.

Strenuous attempts are being made to keep the rubber industry active in Ceylon. As an outgrowth of the benefits derived from past research, the Ceylon Rubber Research Scheme is supported by a tax of one-fourth of a Ceylon cent (roughly 1/12th of a U.S. cent) per pound exported. The producers are active in international control plans and have strong government backing. In addition the government aids the industry with subsidies and other advantages in part paid for by the export taxes on tea. The industry is largely in the hands of Ceylonese who own 59 per cent of the total acreage. British own 38 per cent and others own 3 per cent. The British share is mainly in the large estates which are commonly managed by Colombo agencies. The future of the rubber industry cannot be looked upon with too much hope in Ceylon.

COCONUTS

Almost all of the coconut production is in the hands of Ceylonese. The

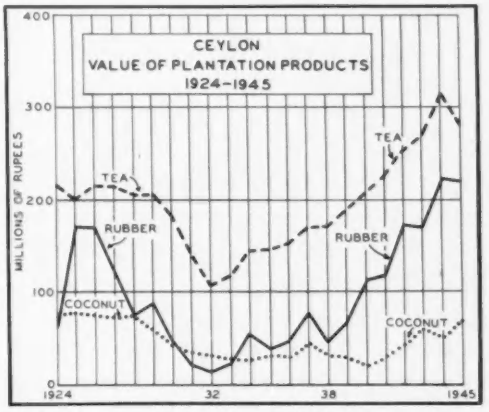

FIGURE 7.—Comparison of Ceylon's rubber exports and world rubber consumption. (Source: Report of the Commission on the Rubber Industry in Ceylon, Colombo, 1947.)

CEYLON'S PLACE IN WORLD RUBBER

	World Rubber Consumption Tons	*Ceylon's Rubber Exports Tons*
1900	51,900	4
1905	61,390	700
1910	73,250	1,697
1915	158,700	22,000
1920	311,300	39,500
1925	551,244	46,000
1930	684,994	76,000
1935	937,000	54,000
1940	1,052,600	88,000
1941	1,200,000	90,000
1942	656,500	115,000
1943	462,000	99,000
1944	260,000	100,000
1945	272,000	96,000
1946	537,000	100,000

Source: Report of the Commission on the Rubber Industry in Ceylon, Sessional Paper XVIII, 1947, Ceylon Government Press, Colombo, October, 1947.

coconut is the most widely spread of all the crops of the island, covering 1,238,000 acres. However, of this area only 451,565 acres are in estates, so that coconuts as a plantation crop is of less importance than rubber or tea. A considerable amount of coconut products does not get into commercial channels, but is used in the village economy. The major center of commercial production is in the lowlands along the southeastern coast, widening out particularly north and east of Colombo. Here the climate is hot and wet, though there are seasonal variations with the monsoon system. The soil is sandy and not well suited to other crops. The terrain is level and canals, roads, and railroads furnish good transportation. The coconut palm furnishes many products and little is wasted. Copra is the major commercial product, in 1945 amounting in value to Rs. 38,803,000 out of a total value of coconut products of Rs. 65,619,000. Copra, the usually sun-dried kernel of the nut, is produced in the northern part of the coconut area where the rainfall is less and the dry period longer. Coconut oil is the second major product, having in 1945 a value of Rs. 21,359,000. Before the War coconut oil, either produced from copra or direct from fresh coconut meat, had severe competition from soy bean and other oils. It's War-time prosperity may not continue though world vegetable oil demands are still heavy. Under agreements in effect until 1950 the government will purchase the entire commercial production of coconut oil and copra, the prices of which have advanced considerably. There are a number of minor products, desiccated coconut, valued in 1945 at Rs. 3,250,000, and fresh coconut, valued at Rs. 2,207,000. In addition, in the coastal belt south of Colombo the trees are tapped for a liquid from which arrack, a fiery drink, toddy, and vinegar are made. The fiber from the coconut husk is made into coir used for ropes, yarn, mattress, and bristle fiber. Finally, poonac, the cake remaining after the oil has been pressed out, has value as a cattle food.

The coconut industry, because of its smaller-scale and less commercial nature,

VALUE OF CEYLON'S PLANTATION PRODUCTS IN THE YEARS 1924–1945

(in Millions of Rupees)

Year	*Tea*	*Rubber*	*Coconut Products*
1924	215	64	74
1925	200	170	77
1926	213	170	75
1927	214	119	72
1928	201	74	74
1929	205	87	60
1930	182	47	43
1931	139	20	34
1932	108	13	33
1933	118	23	26
1934	145	57	26
1935	146	38	32
1936	153	47	29
1937	171	77	42
1938	172	45	31
1939	188	68	30
1940	208	113	20
1941	225	118	24
1942	254	172	42
1943	269	169	61
1944	311	223	51
1945	278	218	66

Source: "Post-War Development Proposals," 1946, Ceylon, Economic Background, p. 3.

is only partly a plantation industry. As other areas and other products have furnished competition, Ceylon's coconut industry has become of less importance. In some years in the last two decades it has exceeded rubber in value of production. During the War it had some increase, but in the post-War period it may be in as difficult a competitive position for world markets as rubber.

MINOR PLANTATION PRODUCTS

There are a number of minor plantation products grown in Ceylon. The remnants of the cinnamon industry covering 26,000 acres have been mentioned before. The areca nut is grown on 69,000 acres mainly in village gardens in southwest Ceylon and is used locally and exported to India. On the lower slopes of the hill regions there are some cacao plantations, but two-thirds of the 34,000 acres are in small holdings. Citronella is confined to 33,000 acres in the extreme southern tip of the island where the high temperatures and the relatively low rainfall is favorable to the growth of the grasses from which the oil is extracted. There are a few large estates of 100 to 300 acres, but most of the production comes from scattered half-acre to one-acre patches. At one time Ceylon had a virtual monopoly of the British and American markets for citronella, but it has suffered through neglect of the quality of the product. The industry is declining in part because of rising labor costs and in part because of competition from Java.

CONCLUSION

The plantations, passing through a varied sequence, have profoundly influenced the geography of Ceylon. The changes in crops have been occasioned by different factors—economic strangulation by government control, diseases to the plants, overproduction, delay in modernization, and valorization schemes. There have been shifts in manner of cultivation and ownership of the plantations. The future of the industries is of great concern to the political leaders since Ceylon under its new constitution becomes a full-fledged part of the Commonwealth of Nations. The plantations have not been an unmixed blessing for they have created numerous problems. The wholesale clearing of the dense tropical forest on steep slopes and the planting of open, weeded trees or bushes without a ground cover have resulted in serious soil erosion. The need for flood control, a paramount physical problem on the island today, is partly the result of the plantation system. The rights of the Tamils, brought in to work on the plantations, is a significant factor in the Singhalese-dominated political scene and in Ceylon's relations with its neighbor, India. The plantations have furnished part-time employment for the surrounding villagers, giving them an important additional cash income without which they would suffer greatly. Three of the four major crops in Ceylon are plantation crops, a significant fact in this predominately-agricultural land. The prosperity of Ceylon depends on its plantations.

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